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THE

QUARTERLY JOURNAL

OF

ECONOMICS

FEBRUARY, 1926

TOWARD AN UNDERSTANDING OF THE METROPOLIS

I. Some Speculations Regarding the Economic Basis of Urban Concentration

SUMMARY

Introductory — Changed scope of city planning and the resulting need for economic assistance, 180. — The problem of an efficient "pattern of population" considered abstractly, 183. — Fundamental importance of transportation advantages in assembling assortments of consumption goods, 186. — Advantages in distributing such assortments, 187. — Consumption advantages of non-urban locations, 188. — Effects upon location of perishability and variation in weight and bulk of goods, 190. — Family unit and location, 193. — Influence of trade-union "exactions," 195. — General factors of retardation and distortion, 196. — Variations in the factors influencing the pattern, 197. — Correlation between growth and variations in relative transportation advantages in history of New York City, 204.

In recent years there has been a growing appreciation of the possibilities of city planning as a means of achieving desirable social ends. A generation ago, beauty and order were the ends dearest to the hearts of the leaders of the movement. "The City Beautiful" was the slogan. By skillful designing of streets and boulevards, by dexterous grouping of public buildings and structures, and by appropriate reservations for parks and open spaces, the artist-planner sought to achieve a symmetrical and

pleasing arrangement. Usually the consideration of the economic aspects of the movement did not go beyond attempted demonstrations that the direct costs of planning could be met from the savings from the ill-considered and wasteful expenditures for public improvements that would be made in any case.

A marked change has taken place both in the conception of the ends to be gained by planning and in the technique and procedure used to achieve those ends. It is not that beauty and order are now considered less important. Rather, it is now realized that an adequate design can be used to achieve other desirable ends as well, and that the product of the pencil and brush can be made more valuable when the artist works in collaboration with the engineer, the lawyer and the economist.

Many developments have contributed to this change. Some of the more important are the keener interest in housing problems and the greater desire to provide adequate recreation facilities for city dwellers; the necessity which has arisen for radical revisions of street plans to care for the expanding automobile traffic; the growing demand for methods of reducing the costs of distributing goods within urban areas, of improving port and terminal facilities and of expanding rapid transit lines; and, finally, the development of the conviction, as the result of the successful use of zoning, that it is feasible and desirable in the interests of the economic efficiency of the city as a whole to subject the private uses of urban land to a much higher degree of collective control than has been exercised in the past.

The planner of to-day recognizes that he must take account of these developments. The modern plan, if it is to be adequate, must make the necessary allowances for the new standards in housing and recreation, must provide a layout of streets adapted to modern traffic,

must recommend a suitable equipment of rapid transit and freight facilities, and must suggest in a general way the economic uses to which the various portions of the area shall be devoted. Some of the practical effects of this recognition have been to change the report of the planner from a small portfolio of beautiful prints to a set of substantial volumes, most of them technical studies of engineers, lawyers, and economists; to change the primary qualifications of the planner from those of an artist to those of a versatile administrator who can coördinate the technique of a group of specialists in varied lines; to change the scope of the plan from a "city" to a larger area, loosely described as a "region," and to change the economic character of the plan from that of a "consumption good" to that of a "production good." Where the early plan was once content to be a noble design, the modern plan aspires to qualify as a productive piece of economic machinery.

The changed conception of the city plan presents an interesting challenge to the economist. The planner now wants to know a variety of things concerning which he feels the economist should be able to inform him. He desires, for example, to be given estimates of the economic value of a plan in terms of possible savings to be effected or positive benefits to be conferred. He asks whether the benefits are of such a character that they may be traced to the beneficiaries, who may be levied upon to recoup the costs. Moreover, he is hungry for economic data for practical use in connection with the detailed formulation of the plan. Since the plan involves suggestions for physical improvements of long life, its usefulness will depend very largely upon how well future needs can be foretold. Any data the planner can secure which will enable him to refine his assumptions regarding the size and the character of the future demand

for space in the territory are grist to his mill. Finally, the planner looks to the economist to explain the city itself — to supply a reasonable explanation of its existence, of its character and its function.

The fundamental problem last mentioned was clearly raised by those responsible for the initiation of the ambitious project for a "Regional Plan of New York and its Environs." Mr. Charles D. Norton, in the original announcement of the project, placed first on his list of proposed studies: "An analysis of the fundamental reasons for the existence of this great center of industry and commerce, its potentialities and the sound limitations on its future development." Mr. C. A. Adams stated in a preliminary memorandum: "What we need first of all is a careful and thoro study of all the activities now located in this district and a grouping of these in the order of their adaptability to this district." [1] Again, Mr. Frederick Law Olmsted said: "Before attempting in any large way to exercise deliberate control over *what* New York is physically to become, we ought to have as clear an understanding as we can reasonably get of the answer to the question, 'What is New York?'" [2] There was clearly present in the minds of all these men a conviction that sound planning involved a clearer conception of the city as an economic phenomenon and an eagerness to understand that phenomenon.

Such, in brief outline, is the broad and virgin field which the economist is called upon to cultivate in connection with modern city planning. Recently a group of studies was made for the Regional Plan of New York, dealing with trends in the location of selected industries

1. Report of Progress, Plan of New York and its Environs, 1923, pp. 29–32.
2. Ibid., p. 29.

in the New York region.[3] In the hope of stimulating criticism and suggestion, the writer has attempted in the rather meager and flickering light of the data supplied by these studies to discuss in the pages which follow some of the forces influencing location, and to restate the explanation of what may be called the "economic map," or the territorial "pattern" in which economic life tends to arrange itself under modern conditions.

As it will be advantageous to discuss the problem in as specific terms as possible, it will be formulated with respect to New York. Moreover, since political boundaries are meaningless here, except as minor factors of distortion or retardation, the discussion in large part will refer to "New York and its environs" or the "New York region." As defined for the purposes of the Regional Plan of New York, this comprehends an area of approximately 5,500 square miles, extending about forty miles into New Jersey, about sixty miles into the States of New York and Connecticut, and to the end of Long Island. In this territory the census of 1920 reported a population of 8,979,055.

In the search for an explanation of the present pattern of population, with its great concentration of people in urban centers, it is illuminating first to consider

3. These studies, which are freely drawn upon without further specific acknowledgment, were made under the direction of the writer, in collaboration with Professor Roswell C. McCrea. They include investigations of the chemical industry, by Mabel Newcomer, the metal industry, by V. W. Lanfear, the food-manufacturing industries, by Faith M. Williams, the wood industries, by Mark C. Mills, the tobacco products industry, by Lucy Winsor Killough, the printing industry, by A. F. Hinrichs, the clothing and textile industries, by B. M. Selekman, Henriette R. Walter and W. J. Couper, the wholesale markets by George Filipetti, the financial district by R. W. Roby, and the retail shopping district, by L. M. Orton. All except the last two have been published by the Regional Plan of New York, 130 East 22d Street, New York City.

abstractly what kind of a pattern would result if one were deliberately to plan a world for economic efficiency. Assume (1) the bare, physical facts regarding the conformations of the earth's surface, regarding climatic conditions and regarding the distribution of natural resources; (2) the present "state of the arts," including the technique of transportation, and the present equipment of capital goods; and (3) a population with economic capacities and desires such as those possessed by modern mankind. Disregarding other considerations, what form would the pattern assume, if the designer aimed to achieve efficiency in production and consumption?

Confronted with the uneven distribution of natural resources, the differences in climate, the variations in the conformation of the earth's surface, the designer is asked to plan to supply as large and rich as possible an assortment of the goods and services desired by modern man.[4] The economies of production to be achieved will, of course, tempt him to utilize the best of the natural resources but the variety of things which he must arrange to supply raises immediately the questions of costs of assembly. He cannot consider the costs of extraction alone. His task is to lay down elaborate assortments of goods and services where they may be conveniently consumed by individuals. He would, therefore, choose among sources not merely on the basis of the relative ease with which quantities of physical goods could be grown or extracted. He could reap the advantages of territorial specialization only by incurring the costs of transportation.

The term "transportation" is here used in the broad sense, to cover all means of overcoming the friction of

4. The pattern would, of course, be influenced to some extent by the inequalities in the distribution of claims to the economic product among individuals.

space. From the point of view of transportation a hill is a grade to be overcome at a certain expenditure of energy. A river is an opportunity to choose a road where the friction is less. A current or a trade wind is a favoring circumstance which reduces the amount of friction otherwise encountered. The conquest of friction is essentially a problem in physics, where the fundamental conditions are set as they have always been set. In terms of the friction of space to be overcome, securing spices from the Indies is the same task to-day that it was in the days of Christopher Columbus.[5] The only essential difference is that man to-day is somewhat more clever in devising methods of overcoming the friction.

The designer would soon realize that under the assumptions only a minor fraction of his available labor force is required to till the soil, to dig the minerals from the earth, and to perform the other types of primary extractive work, and that only another minor fraction is required to man the transportation system and to locate with reference to convenience in performing this function.[6] Consequently a very large part of the population is economically "foot-free" in the sense that it is under no economic compulsion to live "on the land." Where shall the foot-free live? Some, indeed, are in possession of sufficient claims upon the product, without personally contributing toward current production, to enable them to refrain from work and to live wherever they feel they can get the most out of life. Location interests them only as it affects consumption. The great bulk of the population, however, must work and must consume most of what they earn where they earn it. With them consumption and production is practically

5. Unless indeed the seas have become more or less stormy or the currents and winds have changed.

6. Placing the people here involves a service of supply which in turn determines the location of other people.

a simultaneous process and must be carried on for the most part in the same place.[7] To them location is of interest both in its effects upon production and in its effects upon consumption.

A study of possible sources of raw materials and the transportation problem involved in concentrating them at various points would reveal the potential urban sites. Such sites must meet certain requirements of climate, but climate, after all is a matter of fairly broad zones. Within those zones transportation advantages would be, it is believed, the chief determining factors.[8] As among various possible sites served by the same sources of raw materials, the choice will tend to fall in favor of those where it is possible most cheaply to lay down [9] those materials which are destined to enter into the desired assortments of consumption goods. This suggests, then, that the kind of a pattern which would give the greatest economic efficiency under the assumptions stated is one which makes maximum use of territorial specialization within the limits set by the available means of transportation. The most favored spots are those from which the richest resources can be tapped with the lowest transportation costs. At such points would develop the great cities. Smaller urban centers would be expected to appear at less favorable points, to the extent that, in accordance with the law of diminishing returns, the degree of intensity of utilization raised costs and thus forced a resort to the poorer resources.[1]

7. Cf. infra, pp. 193, 194.

8. As among particular sites, the question may narrow down to the transportation costs of securing an adequate supply of pure water or of disposing of sewage. New York transports its water from the mountains and dumps its sewage in the harbor. Chicago draws its water from the lake and transports its sewage to the Mississippi.

9. Economies of distribution are discussed on page 190.

1. It should be noted particularly that it is the pattern of population distribution rather than the aggregate size of the population or of urban centers which is here under discussion. Cf. infra, p. 198.

In the lower cost of supplying consumption goods at these convenient assembly points is found, then, a positive and, in the opinion of the writer, a very powerful force tending constantly toward the concentration of the entire "foot-free" population in urban areas. To justify locating a person elsewhere some advantage in production or in consumption must be obtainable sufficient to counterbalance this fundamental advantage of concentration.

This analysis leads to a rather novel conception of the relationship between urban and rural areas. The conception of this relationship which forms a part of the mental furniture of a surprisingly large number of people is that the city is a parasitic growth, nourishing itself on the life-blood of the country. In sharp contrast, the above analysis suggests that, while the cotton and the corn, the copper and the coal are obviously essential, and while a part of the human race must always devote a part of its energies to their extraction or production, what is really wanted, in this modern day, by the farmers and the miners as well as by the clothing operatives and the artisans, are complicated assortments of shirts, breakfast foods, radios, and warm radiators; and that, since to provide such assortments at places far removed from the favorably-located concentration points is relatively costly, every unnecessary man on a Saskatchewan wheat farm or in an Arizona copper mine involves a preventable economic waste, a useless addition to the agony of getting the world's work accomplished.

To persuade a sufficient number of persons to remain on the farms and in the mines, it is necessary to offer them an assortment of consumption goods comparable with that obtainable in the city — not an identical assortment, to be sure, but one which is sufficiently rich

to compare satisfactorily with it.[2] Relative costs of delivering such assortments at the farm or mine is undoubtedly a factor influencing the development of this or that urban center. Such assortments must, of course, be delivered to others as well as to the laborers in the "extractive" and transportation fields. They must be delivered to all those who for reasons about to be discussed, find their proper place in the pattern outside the urban centers. Since, however, in the distribution of assortments the same transportation advantages are effective which operate in assembling the raw materials entering into the assortments, the effect of this factor in changing the theoretical pattern is probably not very great. A good assembly point will also be a good distributing base.[3]

The acceptance of the suggestion developed above changes the character of the explanation of the actual existing pattern of population. Instead of explaining why so large a portion of the population is found in the urban areas, one must give reasons why that portion is not even greater. The question is changed from "Why live in the city?" to "Why not live in the city?"

There are, in the first place, certain obvious advantages on the side of consumption which cannot be separated and carried to the city for use, and so may operate to draw to sites elsewhere. The mountain lake must be enjoyed where it lies. The "vast open spaces" have a charm which cannot be delivered, like a bottle of milk, on the doorstep of the urbanite. To obtain it one must sacrifice part of the rich assortment of consumption goods offered in the city. A few

2. Thus, for example, it is advantageous to utilize for farming persons who prefer the songs of the birds to those of opera stars!

3. The economies of the "back-haul" are of importance here.

value these so highly that they make the substitution. Many compromise. Witness the vacation habit.

It is granted, also, that there is a propelling as well as an attracting force in the situation. City life, even under the best conditions, is often crowded and complicated, full of strain and risk. Some, like the country mouse of the nursery rhyme, prefer plain fare with peace to the royal feast under city conditions, and join in chanting the refrain:

> Fare you well! If you have pleasure
> You have also fear and care.

However, country mice appear not to bulk large in the aggregate figures of the urban trend.

The theoretical pattern developed above, based on limited assumptions, calls for the location of all business functions, except the extractive and transportation functions, at the concentration points, in urban areas. So far as all of the other functions, except certain types of fabrication, are concerned, the theoretical pattern conforms closely to the actual pattern. Managing and administering, buying and selling, financing and risk-bearing, investigating and advising — these are among the functions which find the city very congenial indeed. However, a considerable part of the processes of fabrication, of preparing materials for human consumption can be and are carried on more economically outside the urban centers.

The figures presented in the table indicate that on the whole fabrication flourishes very well in New York and its environs. The factory employees in the entire urban area increased 83.6 per cent between 1900 and 1922.[4] Between 1900 and 1920 the population of the

4. The number of factory employees in the center of the city (Manhattan Island south of 59th Street) increased only 44.8 per cent.

area increased only 66.8 per cent. All of the industries except wood and tobacco have a higher rate of growth than population.

EMPLOYEES OF FACTORIES CLASSIFIED BY INDUSTRIES IN NEW YORK AND ITS ENVIRONS IN 1900, 1912, 1917, AND 1922, WITH PER CENT OF INCREASE, 1922 OVER 1900*

Industry	1900	1912	1917	1922	Per cent increase 1922 over 1900
Chemicals	28,020	45,007	62,411	70,501	151.6
Men's clothing	50,096	107,228	115,180	107,899	115.4
Women's clothing	70,312	137,197	162,134	150,195	113.6
Metals	150,461	229,090	270,912	269,079	78.8
Printing	42,303	62,257	68,233	73,344	73.4
Food	48,322	67,532	69,872	82,472	70.7
Textiles	73,409	110,629	106,209	123,761	68.6
Wood	42,999	63,974	51,111	55,563	29.2
Tobacco	23,839	30,345	21,291	26,495	11.1
All others	127,226	204,988	216,306	246,814	94.0
TOTAL	656,987	1,058,247	1,143,659	1,206,123	83.6

* Between 1900 and 1920 the population of this area increased from 5,384,734 to 8,979,055 or 66.8 per cent.

But fabrication also flourishes elsewhere. One of the reasons for this variation from the suggested pattern is to be found in two physical qualities of goods in process of fabrication, namely, perishability and variation in bulk and weight. These qualities are significant only because of their relation to the task of transportation. Perfect transportation is transportation without cost in time or energy. So long as a transportation is imperfect, if an article is to be transported at all, an interval of time is necessarily involved. In some cases an interval of time cannot ensue without spoiling the article. Perishability is, of course, a relative term, and, with high speed and with artificial refrigeration or heat,

many articles are carried long distances to-day which were available only at their point of origin a few years ago. But perishability still remains an important factor in determining the location of certain fabricating functions. Thus if articles which spoil quickly are to be preserved by drying or canning, these processes are usually best performed near the point of extraction. New York City's canneries prove, upon analysis, to be, for the most part, salvage plants designed to preserve the surplus supplies of temporarily glutted markets, supplies which would otherwise decay and be wasted. Perishability during some intermediate process of fabrication tends to bind processes together at one place. Certain plants which utilize the by-products cluster close to the packing houses. Finally, in cases where the articles are highly perishable in the last stages of preparation, this circumstance operates as an additional reason for locating the final processes near the center of consumption. The Kosher rules forbidding the eating of meat more than seventy-two hours old artificially increase perishability and are largely responsible for the surprisingly great slaughtering industry in New York. The New York evening newspapers are printed only a few minutes walk away from the points where the home-going throng enters the subway.

Again, so long as transportation is imperfect, if an article is to be transported at all, some expenditure of economic energy is necessary. In certain cases the amount of energy necessary is materially affected by the location of the place where the process of preparation is carried on. Many products, as originally extracted, contain a large amount of material which is discarded in preparing it for use, resulting in a great reduction of bulk or weight. To make 100 tons of pig-iron requires 130 tons of coal, 200 tons of ore, and 25

tons of limestone. In view of these facts it is easy to understand why New York has no blast furnaces. Even in the case of the iron foundries, where the percentage of waste is much smaller but is seldom less than 8 per cent, there is a strong trend away from New York and toward the Pittsburgh district.[5] In a porphyry mine, a hundred tons of ore may produce but one ton of copper. Consequently smelting is ordinarily done near the deposit. The small amount of smelting done in New York is restricted almost entirely to South American ore from small mines, far distant from a fuel supply. In contrast with smelting, copper refining involves a relatively small reduction in bulk and weight. No less than 55 per cent of the country's copper refining is done in the New York area.

On the other hand there are products which expand in bulk and weight at later stages of their preparation, through the addition of free or almost free elements such as air and water. The manufacture of certain chemicals such as sulphuric acid involves a marked expansion in bulk and weight through the addition of water in the final stages, and in such circumstances is found part of the explanation of New York's high position in the chemical industry. A small bundle of staves is transformed into a large barrel. New York has its full complement of barrel and box factories, and of shops for setting up "knocked-down" furniture. Automobiles are manufactured for the most part in the middle west; but in the fact that only three assembled machines can be shipped in a box car, whereas several times this number can be carried if the machines are not put together, is found a reason for the large number of automobile assembly plants found in the metropolitan area.

5. At present there are only five foundries on Manhattan, whereas at one time there were at least sixty-five.

In many cases both spoilage and changes in bulk and weight are involved. Bread is not only more bulky than its constituent elements, but it is also highly perishable in its final stages. New York bakes its own bread. Again, sugar-cane yields, at best, only 12 per cent of its weight in sugar, and unless the juice is extracted and boiled down within twenty-four hours after the cane has been cut in the fields, it deteriorates rapidly. Consequently raw sugar is made in centrals located in the midst of the cane fields, in spite of the shortage of fuel there. New York, however, is a great center for sugar refineries; with only a slight reduction in bulk, they transform raw sugar into the article of ordinary consumption.

Also very important among the circumstances which cause fabrication to be located elsewhere than in urban areas is the desire of a man for a wife and a family. Altho exceptions are numerous and are perhaps becoming more frequent, the man is usually the economic head of the household and it is usually with reference to the furtherance of his economic welfare that the question of location is decided. The decision is commonly made before he has a family. But the family, after it arrives, is held together, with greater or less success, in spite of economic advantages which would often follow its dissolution.[6]

The farm, of course, offers a remarkable opportunity [7] to apportion economic activity among the members of the family according to their varying abilities. How-

6. It is not the purpose here to formulate an economic theory of the decay of the family as an institution, but it is readily seen that there is a strong economic force in the trend toward the efficient pattern of population distribution which works toward the disintegration of the family unit in non-urban areas.

7. Altho not so good an opportunity as before the factory system superseded the handicrafts.

ever, the other extractive industries, the mines, the lumber camps, and the fisheries, as well as many [8] of the first-stage processes of fabrication where the percentage of reduction in bulk and weight is great — the steel mills and the smelters — require man-power, not the light labor of women and children. In some lines, as in the lumbering of virgin forests, the conditions are such that the industry is of necessity carried on predominately by womenless men; but in lines where this is not the case, the result is often an available pool of unutilized women and child labor. This is obtainable at low rates of pay as compared with the ruling rate for similar labor in the urban centers. As a consequence, certain types of light industry find the advantage of cheap labor sufficient to leave a surplus after offsetting the advantages of location in an urban area.

The location of light industry with reference to the location of heavy industry utilizing male labor has been noted many times and such light industry has sometimes been termed "parasitic." [9] According to the analysis here presented, such a term would scarcely be justified. While it is true that its location is determined by the location of the heavy industry, it does not derive its economic sustenance from the heavy industry. The arrangement may be more properly considered a sal-

8. Not all, however. In some fishing communities, for example, the demand for women laborers in the canneries is greater than can be supplied from the families of the fishermen.

9. "Where metallic and engineering works naturally congregate, industry offering some work of lighter character, whether hand-work or machine tending, suitable to busy women and children, will be apt to appear." Marshall, Principles, p. 331 (1st edition).

"As textile work passes more and more into the hands of women, this tendency to make it a parasitic trade, thriving upon the low wages for which women's labor can be got, where strong and well-paid male labor is established, will probably be more strongly operative." Hobson, The Evolution of Capitalism, p. 113. Cited by E. A. Ross, "The Location of Industries," Quarterly Journal of Economics, April, 1896, p. 255.

vage device for utilizing economic energy which would otherwise run to waste. If the male worker desires a family, he must be paid enough to maintain a family in idleness unless suitable supplementary work is provided for his family.

The anthracite coal district of Pennsylvania is the area nearest New York which offers an opportunity for supplementary light industry. Partly because of the attractions offered there and partly because of difficulties with the unions in the Jersey towns in the environs of New York, there has been a large exodus of silk factories to that district. It is significant that in Pennsylvania the silk weavers are roughly 40 per cent male and 60 per cent female, while in New Jersey the proportions are reversed. Certain branches of the clothing industry, especially those in which the product is standardized and the fashion element unimportant, such as housedresses and overalls, find the opportunities in Eastern Pennsylvania attractive. This is true, also, of cigar factories of medium size utilizing hand labor rather than machines.

A third important circumstance in influencing the location of fabricating plants in the country is the fact that trade unions appear to find it an easier task to organize and control workers in a large city than those in less densely settled territory. Usually, therefore, standards of wages and shop practices are not uniform in their application over a wide area. Local differences, traceable to this same cause, persist. In some lines of activity in New York City, there is much complaint regarding the competitive disadvantage suffered because of the "exactions" of trade unions. The clothing manufacturer who announced to an investigator his intention to move his plant from New York to some town

where he could "tell those damned Bolsheviks to go to hell" undoubtedly voiced the sentiment of many exasperated fellow employers. In the printing industry, also, this circumstance is of great moment, occupying an important place in the arguments of both the employers and unions in the wage negotiations of recent years. The situation in the silk industry has already been mentioned. Finally, some of the cigar manufacturers blamed the decline in the importance of the industry in New York upon the activities of the union.

It is conceivable that a well-organized union may, by insisting upon high wage levels and costly shop practices, increase the cost of production of a manufacturer to a point where he may be forced to seek a site outside the circle of union influence. Certain types of fabrication, however, newspaper printing for example, are not free to move, and the higher costs may be resolved into a general charge upon all the residents of the city. In either case the effect is to distort the theoretically ideal pattern. The unions, of course, insist that their demands are justified by the superior productivity of their workers and deny that they result in higher costs.

The three circumstances discussed above are found to recur over and over again in the explanations of business men regarding shifts in the location of fabricating establishments between city and country. They constitute, it is believed, the chief reasons for the location of factories in non-urban territory. Certain general factors of retardation and distortion, however, deserve mention.

Here belong, for example, the "non-rational" and "rational-but-personal" causes, listed by Ross in his

admirable article.[1] A distressingly large number of business men replied to the questions of the investigators regarding location with a frank "God knows." But not all choices are bad simply because they are non-rational. Moreover, those who choose badly are very likely to be compelled before long to make another guess, and, by a process of trial and error, tend to be brought toward the form of the theoretically perfect pattern.

Climate, already taken into account in connection with the assumption regarding the distribution of natural resources and again as a factor bearing in a general way upon the location of urban centers, sometimes operates to retard or to encourage certain processes of fabrication. In recent years, however, progress in the artificial control of atmospheric conditions in plants has reduced greatly the importance of this factor.[2]

Water power is usually dignified by a separate place in the older discussions of location. Ross, writing in 1896,[3] said: "Water power . . . has not been portable in any form, and, if used at all has to be used in strict connection with the falling water which generates it." To-day when the transportation of water power in the form of electrical energy is very largely a function of the price of copper, its importance is relatively insignificant except in a few cases, such as that of the aluminum industry, where power costs loom very large in the expenses of manufacture.

Mere inertia is responsible for much of the distortion of the pattern. The pattern itself is a constantly changing one. A considerable lag is inevitable because of

1. Loc. cit., p. 247.
2. Thirty years ago Ross remarked: "The packing business settles in latitudes where the ice crop is sure to be cheap and plentiful." Loc. cit., p. 251.
3. Loc. cit., p. 254.

ignorance of where one's economic interest lies or to lack of energy to take prompt advantage of it. This lag is accentuated by the presence of disturbing legal restrictions and of economic obstacles to change. It must be remembered that change itself requires an expenditure of economic energy and the new location must promise sufficient advantages to offset this cost as well as any sacrifice of non-transportable fixed capital which may be involved. One legal restriction now strongly influencing the situation in New York is the new immigration law. Among the minor factors are political influences and the effect of other social institutions than the family, discussed above.

Finally, among the distorting and retarding forces, may be properly listed the faults in design and layout of the urban centers themselves, which prevent the full utilization of their fundamental advantages. The concentration of population in urban areas does not necessarily involve congestion, although under present conditions congestion with its attendant costs and evils does exist. In the sense in which the term is used in this article, an urban area includes not merely the city but the environs as well, an area sufficiently great to be able to offer in its outskirts large plots of cheap land for such plants as require them, and in general, to provide the advantages obtainable in a rural location, with the gains of ready access to the center of the city as well.

Let it be understood, that this discussion relates to the reasons for the *pattern* of population distribution. No attempt has been made to explain the aggregate size of the earth's population. That is quite another problem, one in which the efficiency of the pattern itself is one of the determining factors. The reasons advanced in the foregoing pages may explain the relative size of New York as compared with other cities. They do not

pretend to explain its absolute size. Nevertheless the explanation there developed is useful in speculating regarding the future of New York City. If estimates can be made of the probable future increases in population, New York's share of that increase can be more intelligently considered in the light of the analysis of the forces determining the pattern.

If one abandons the assumptions made on page 184 and, after glancing backward a hundred years, tries to imagine what will occur in the next hundred years, the difficulties connected with the formulation of definite estimates seem so appalling that one wonders that there exist persons with courage to make them. Yet the mere elaboration of some of the undetermined variables is very suggestive, and is an aid to intelligent speculation.

In the first place, even natural resources and climate hold possibilities of significant change. Forests, mines, and soils are subject to depletion. Moreover, the race is not yet fully aware of what its resources are. Only the more obvious facts are known. New oil wells and new mines are being discovered daily. Every change in resources has a potential effect on the pattern. Thus it is conceivable that increasing difficulties of securing fuel in the distant future may cause urban centers in the south to displace the present great cities of the north. Or, at a cost of duplication of plant and considerable expenditure for transportation, the population may migrate on a grand scale between northern and southern cities with the seasons.

The possibilities of changes in natural resources seem relatively insignificant, however, compared with possibilities of changes in the technique of production and transportation. The pattern of population distribution is dependent upon a technique which may be revolu-

tionized almost any moment by the discovery of some obscure worker in a laboratory. When one considers the effects of the invention of new agricultural machinery and of the application of scientific methods in agriculture, he becomes less concerned regarding the probable effects of soil depletion. When it is recalled that the use of oil and coal for fuel dates back only a few years, one wonders what stores of energy, at present quite without economic significance, may be released by the magic of the fuller knowledge of the future. Even the importance of soil fertility, as a factor influencing the distribution of population, may be greatly diminished by new discoveries for extracting nitrogen from the air or developments in the science of nutrition.

It is necessary only to recall the industrial revolution which followed the development of power-driven machinery a century ago, to appreciate the important effects upon the productivity of labor and the scale of production which may follow future changes in industrial technique. The possible effects of changes in the technique of transportation are perhaps even more important. Man's means of dealing with space have been revolutionized in recent years, and it seems probable that as scientific knowledge advances, applications in the field of transportation will be both prompt and important. Only in the present generation, after centuries of bondage to earth and water, has man inaugurated transportation by air. Its possibilities are still only faintly perceived, but that it will profoundly affect the future economics of transportation none can doubt. The transmission of electric power, the telephone, the radio, the internal combustion engine, all testify to the highly dynamic conditions in this field. In fact, the technique of transportation is a veritable volcano of possibilities, whose unpredictable eruptions may be devastating in

their effects on predictions of population distribution.[4] These possibilities must be constantly borne in mind in seeking a glimpse of the future of the metropolis.

It may be pointed out, however, that whatever the improvements of transportation, perfection can never be reached. Men may lessen but not destroy the friction of space. A new automobile engine may greatly reduce but will not eliminate entirely the time and effort necessary to move over the earth. A new wind-ship may be cheaper or faster than the present type of vessel, but instantaneous and costless water transportation is still far away. Better aeroplanes will undoubtedly be built, but even tho San Francisco is brought within an hour of New York, instead of a day, an hour remains an hour. It is, of course, possible that transportation by air will develop to a point where the influence of conformations of the earth's surface will be relatively insignificant, as compared with the situation at present. Location on navigable water, now so important, may for this reason become less imperative. But so long as surface transportation continues to be used at all, the seaport will possess an advantage. In any type of transportation, by land, air, or water, a mile will always represent a certain amount of friction to be overcome. But in spite of these considerations, the importance of other

4. The Bureau of Standards, of the United States Department of Commerce, for example, has issued a statement based on reports from experts in the bureau predicting air commuting within a decade: "The effect of the airplane, if developed as is expected, will be to extend very greatly the distance to which such trips can be made in a given period of time. They will permit commuting from distances of a hundred miles, while week-end trips can be made from New York to the Thousand Islands; from San Francisco to Yosemite; from Washington and Baltimore to the mountains of Virginia, and from Boston to the Maine woods. If the visions of the experts materialize, people whose business requires only occasional visits to the city can spend their winters in Florida and their summers in Nova Scotia and still keep in touch with business interests in New York."

variable factors is so great that the effect of possible improvements in transportation may be only dimly foreseen.

It should be borne in mind that progress in the arts, even with a stationary population, means in itself an increase in potential urban population. When a new railroad makes possible the use of richer land, the makers and operators of the railroad are in a very real sense replacing farmers. When an improved agricultural implement is introduced, farming is transferred to a factory. A scientist in an agricultural experiment station who discovers a cure for a cattle disease is the equivalent of many stock-raisers. All such improvements release population from the land and this population can be best cared for in the cities.

Any progress in the arts of transportation and refrigeration will have the effect of reducing the portion of the population engaged in preserving and canning. The future population of New York will eat more fresh fish, fruit, and vegetables and fewer canned goods and preserves. In the case of processes for reducing bulk and weight prior to transportation, the case is more complicated. At any given time the amount of fabrication of this kind is the result of an equation which includes such factors as the reduction in the cost of transportation effected by resorting to the processes and the wages of the workers. Improvements in transportation will lessen, but never eliminate, the saving to be made by fabricating near the deposits; but the terms demanded by the workers who man the plants may increase. Moreover, if in mining the exhaustion of deposits forces resort to low-grade ores, or if in agriculture poorer land must be cultivated, the number of persons required will be increased. Here it is impossible to make any definite forecast. On the whole, however, probably no larger

portion of the race will be localized in the future than at present because of transportation changes. While it is probably safe to say that the improvements in the technique of transportation which may be expected in the next four or five decades will greatly reduce the time and cost of carriage by water and land, and perhaps even more by air, it is scarcely probable that the improvement of any one of the three types will render obsolete the use of any of the others. That is, fifty years from now all three modes will still be used, altho the air may carry many things which are now carried by land or water. Any material growth of transportation by air will tend to minimize such differential advantages of New York as rest upon favorable conformations of the earth's surface and upon the harbor. But those advantages will continue in effect to the extent that air transport does not entirely replace the others. When one considers the fact that the improvements in air transport will depend largely upon the development of more efficient engines and that these same improvements will be available for use in land and water transport, the remoteness of the entire obsolescence of these two modes becomes apparent.

The character of the wants and desires of man also varies. The assortments of the particular commodities and services consumed in the effort to satisfy human wants are always undergoing a process of change. Within recent years, for example, the American people have (nominally, at least) discarded the use of strong drink from their list of consumable goods; on the other hand, they have added the automobile and the radio. In general, a comparison of the goods consumed to-day with those consumed only a few years ago thus shows remarkable changes. None the less, one generalization regarding these changes should be referred to. The

changes in wants appear to be, on the whole, in the direction of the refinements of fabrication and service rather than in the direction of the mere multiplication of units of raw products. The chief significance of this for the future pattern of population lies in the fact that this permits of relatively great concentration of people by reducing the proportion which is required to man the resources.

The recent past has been marked by a rapid growth of capital. The increase in productivity which results from the lavish use of machinery has been largely responsible for this growth. In the absence of revolutionary changes in social institutions, there would appear to be little reason to anticipate any marked reduction in the rate of capital accumulation in the years to come. Since the explanation advanced in this article calls for the concentration of the foot-free population in urban communities, and since increase of capital in non-urban activities will tend to reduce the human labor required to achieve a given result, the growth of capital would seem to be properly listed as an influence making for a larger future urban population.

The possible future changes in the factors of retardation will depend largely upon the possibilities of increased intelligence, of better education, of less national and industrial animosity. Optimism regarding these possibilities leads to the view that the retarding factors will prove to be of diminishing rather than increasing importance with the passage of the years.

A survey of the economic history of New York City [5] raises numerous questions which deserve thoro examination. At the eve of the Revolution, New York was

5. These paragraphs are based on a memorandum prepared for the Regional Plan of New York by Professor T. W. Van Metre.

less important than either Boston or Philadelphia. Was Boston's prosperity attributable to her favorable location with reference to the fishing banks, fish at this time being, next to tobacco, the most important article of export? Was Philadelphia's superior development caused by her richer immediate hinterland at a period when difficulties of land transport and the stage of settlement made that hinterland alone significant which was immediately adjacent?

By 1790, in spite of the fact that the Revolutionary War had borne upon her with particular severity, New York had passed both Boston and Philadelphia. Is the explanation of this to be found in comparative advantages possessed by New York in relation to the rapid extension of ocean transport after the Revolution in the direction of new contacts with the countries of northern Europe and with the Orient?

From 1790 until the war of 1812, New York continued to strengthen her position. During this time she gained a relatively large share of the profitable re-export trade in French colonial products, such trade constituting the major portion of her commerce during these years. Was New York's success in this competition traceable to the fact that the city is favorably situated with relation to the West Indies, being nearer the sea than Philadelphia or Baltimore and farther south than Boston? During the same period New York gained a commanding position as an exporter of domestic products. Was the factor which brought this about, the improvement in inland transport, consisting of the excellent turnpike system constructed after 1790 to connect the larger exterior villages and towns with the Hudson River, or was it Robert Fulton's steamboat, put into operation in 1807 between New York and Albany?

After the War of 1812 New York entered upon a

period of exceedingly rapid growth which left her rivals far behind. By 1860 she had become the leading manufacturing city of America. By that year she also had nearly one-half of the total foreign commerce of the country, and her nearest rival was not Boston, Philadelphia, or Baltimore, but New Orleans. Are the economic historians correct in their conclusion that the fundamental reason for this great success was the utilization of the low-level route to the middle west through the construction of the Erie Canal, completed in 1825, which greatly increased the territory tributary to New York? [6]

By 1860 the railroad had begun to exert a large influence. New York, with its unrivalled facilities for water transportation, developed somewhat slowly as a railroad center. So intent was New York State upon preserving the business of the Erie Canal that it forbade the early railroads now included in the New York Central system to carry freight at all, or required them to pay into the state treasury, for all freight carried, an amount equal to the tolls the state would have received had the traffic passed through the canal — restrictions not removed until the eighteen-fifties.

The three decades following 1860 witnessed a tremendous expansion of railroad facilities and established an entirely new transportation situation, in which the Erie Canal played a relatively insignificant part. On this new plane of competition New York's advantages as a transportation center were undiminished. In addition to the New York Central in the Hudson and Mohawk valleys, the Erie, Lackawanna, and the Lehigh Valley were early pushed through the southern tier of New York counties to the Lake, and the Central Rail-

6. Within a score of years after its completion the major portion of its eastbound freight originated west of Buffalo.

road of New Jersey was constructed further south. Even the Pennsylvania Railroad, Philadelphia's project, and the Baltimore and Ohio, Baltimore's bid for the commerce of the middle west, were themselves woven into the transportation equipment of the metropolis. By 1890, all the western trunk lines terminated at the New York harbor. Under the régime of railroad transportation, which greatly extended the hinterland, New York retained her supremacy in the import trade and gained substantially in exporting.

Since 1890 the port of New York, while still continuing to grow, has declined in relative importance. How far is this caused by the commanding position which cotton has assumed in the nation's exports; by the rapid exploitation of the resources of the south and southwest; and by a failure to develop the facilities of the port to the extent justified by its fundamental economic advantages?

It would be interesting to make a careful historical study of the development of cities in general, to ascertain how important economic factors have been in determining the rate of growth and relative standing of the urban centers at various periods. While such a study would almost certainly show that non-economic factors were formerly of greater importance than they are to-day, is it not probable that it would show also that, even in ancient times, population tended much more strongly than is generally realized toward the pattern which was efficient economically in view of the knowledge of natural resources and the state of the art of transportation existent at the time?

The writer does not pretend to have demonstrated the soundness of the hypothesis developed in this article. With the data at present available such a demon-

stration probably cannot be made. The hypothesis is simply the best explanation of the phenomena he has been able to evolve. He hopes that other students will be quick to correct the faults, errors, and omissions which are doubtless present in abundance, for the time has come when it is highly important that progress be made toward an understanding of the metropolis.

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CHAPTERS ON MACHINERY AND LABOR

IV. The Introduction of Machinery and Trade-Union Policy

SUMMARY

The conflicting interests of the trade union in the introduction of machinery, 209. — Trade-union policies, 210. — Opposition to machinery, 211. — Reduction in wage rates of hand-workers, 214. — Employment of hand-workers as machine operators, 218. — Reduction of inflow into the trade, 221. — Distribution of work, 224. — Conclusions, 227.

In the preceding chapter, in which the factors determining the amount of displacement of skill caused by the introduction of machinery were considered, the discussion was based on the assumption that economic forces were working in a purely competitive régime. The most important modifying influence thus disregarded was the action of the trade unions of the hand-workers affected. The present chapter, therefore, is devoted to the various forms of action by which a trade union may lessen or avoid the displacement of skill. The facts have been drawn from the same studies of particular cases that were used in the preceding chapter.[1] In all the cases, at the time of the advent of the machine, there were unions in the trades affected. These trade unions were among the oldest and most powerful in the United States.

The interest of a trade union of hand-workers in the introduction of machinery affecting its membership is

1. See this Journal for November, 1925, where will be found, at page 113, an enumeration of the studies made by the writer to which further reference is made in the foot-notes of the present chapter.

twofold. In the first place, there is grave danger that the standards of employment of the hand-workers may be broken down during the period of introduction. The surplus of skilled men occasioned by the introduction of machinery may be so great as to make it impossible for the union to maintain wages and other conditions of employment at the former level; indeed, the existence of the union may be endangered if the surplus in the trade becomes sufficiently large. Secondly, the union has a sympathetic interest in preventing, as far as may be possible, the reduction of part of its members to the ranks of the unskilled.

These two interests are by no means equal. If a machine threatened within a brief time to displace all the hand-workers in the trade, doubtless the interest of the union would lie chiefly in the avoidance of displacement from the trade and not in the maintenance of the standards of the hand-workers left in employment. This is rarely, however, the case. Machines are introduced gradually; the scope of the machines is slowly enlarged, until the period of introduction is over. At any given time the union is interested in displacement from the trade chiefly as it reacts upon the working conditions of the skilled men still employed in the trade. It is not, therefore, the avoidance of displacement from the trade which forms the primary concern of the union, but that partial displacement of skill characterized by lower wages and longer hours for the hand-workers. Occasionally, as will be illustrated at several points below, these two interests are served by the same policies, but when this is not the case, the union is sure to give preference to those measures which are designed to maintain standards of employment.

Trade-union policies with reference to the introduction of machinery may be divided into five types, ac-

cording as they are designed: (1) to prevent the introduction of the machine, (2) to increase the amount of work going to the hand-workers by decreasing the wage for hand-work, (3) to enlarge the field of employment for hand-workers so as to include the operation of the machine, (4) to reduce the inflow into the trade, and (5) to distribute more widely the work left to the hand-workers. These policies will be considered in order.

(1) Experience has convinced the greater part of well-informed trade-union leaders that the introduction of important labor-saving machinery cannot be permanently halted by trade-union action. In 1905, when the Owens bottle machine was being introduced into the trade, President D. A. Hayes of the Glass Bottle Blowers' Union said, "Working men in England during the first half of the last century fought desperately against the introduction of labor-saving inventions, but always to their own disaster. We have seen many instances of the same kind in this country and the ranks of non-unionism have been augmented thereby."[1] The same opinion has been expressed by many other trade-union officials on numerous occasions and in many reports. Not only is trade unionism officially committed to the view that resistance to machinery is futile, but it is almost unanimous in holding further that resistance to the introduction of machinery delays, or makes impossible, the adoption of measures which may mitigate the hurtful effects of the introduction of machinery.

As a matter of actual practice, however, it not infrequently happens that trade unions do attempt to prevent the introduction of machinery. In the cases of the introduction of machinery examined, such attempts were made by the Flint Glass Workers to stop

1. Proceedings, Glass Bottle Blowers, 1905, p. 27.

the introduction of the semi-automatic bottle machine and by the Stonecutters to stop the introduction of the stone-planer. This divergence between teaching and practice is explained primarily by the simple fact that while the official point of view may be clearly understood, it is not binding on any particular union.

When machinery is first introduced, the line between those displaced from the trade and the survivors has not yet been drawn. Every member of the union is potentially a displaced workman. The only policy, therefore, which fulfills the hope of every member is that of completely stopping the progress of the machine. Where the members feel that the union is very strong in its control of the hand-workers or can count on the powerful aid of allied trades, the hopes of the members may prevail against the counsels of their leaders and against the experience voiced by official trade unionism. Particularly is this likely to be the result in those unions in which the formulation of a policy with reference to machinery falls into the hands of the local unions. Where the control of the national union is greater, the likelihood of dealing with the question on a better-informed basis is also greater.

These influences may be illustrated from the histories of the stone-planer and of the semi-automatic glass bottle machine. When the stone-planer was introduced, the national union of the Stonecutters was very weak. In most of the large cities the local unions were entirely independent. The largest of these independent unions — the Chicago union — initiated a campaign against the use of the planer and it spread to the branches of the national union. The policy of opposition thus developed was ultimately forced upon the national union.[2] The forms of opposition varied from place to

2. "The Stonecutters' Union and the Stone-Planer," pp. 421–424.

place and from time to time. In some localities, prohibition of the use of the planer was combined with a rule against the shipment of planer-cut stone from other places. In other unions, a milder form of hindrance in the form of rules restricting the number of planers in proportion to handcutters was in vogue.

The attempt of the Flint Glass Workers' Union to stop the introduction of the semi-automatic bottle machine by requiring the same piece rates on the machine as on hand-work is not to be explained by local independence.[3] The Flint Glass Workers' Union is highly centralized and the policy of the union was determined by national officials. These officials did not assent to the general opinion that attempts on the part of a union to prevent the introduction of machinery are likely to be not merely futile, but to retard or prevent the introduction of measures likely to be helpful. The union was very strong and was enforcing at the time many other rules severely restricting production.[4]

Against these attempts to hinder the introduction of machinery, may be placed the frank acceptance of the semi-automatic bottle machine by the Glass Bottle Blowers' Union and of the linotype by the Typographical Union. The same attitude was assumed by the Glass Bottle Blowers' Union when the flow and feed devices for making glass bottles were introduced. The introduction of the Owens bottle machine was peculiar in that the question of union jurisdiction over the machine was not pressed until late in its history, but the Glass Bottle Blowers' Union allowed its members to work at hand-work in the plants where the machine was operated by unskilled workers.

3. "The Introduction of Semi-Automatic Bottle Machinery," pp. 345, 346.

4. "Regulation and Restriction of Output," Eleventh Special Report of the Commissioner of Labor, Washington, 1904, pp. 624–662.

In both of the instances where the unions opposed the introduction of machines, the results were disastrous. The employers transferred the work to non-union plants or employed non-union men. The unions thus lost the opportunity to use other measures for the avoidance of displacement of skill, which depend for their efficacy upon the extent to which the union controls the industry. That the opposition of these unions did retard the introduction of the machines is undoubted, but no measures were taken looking to the utilization of the period of retardation as a means of salvaging skill. It is not to be inferred from these instances that the policy of opposition is necessarily always unsuccessful. Situations are conceivable in which a union could successfully apply this policy. If the saving by machine production were small, and the control of the union over coöperant workers complete, it is quite possible that a policy of opposition might succeed, at least for a period sufficient to give an opportunity for reducing the number of hand-workers. In the cases under consideration, however, the unions failed and in most cases this must be the outcome of such attempts.

(2) From one point of view, the lowering of wage rates may be regarded merely as an attempt to hinder the progress of the machine,[5] but it may more properly be regarded as competition with the machine, involving no more of the element of obstruction than other forms of competition. Sidney and Beatrice Webb in *Industrial Democracy* urged as one of the cardinal points of trade-union policy in dealing with machinery that

5. When the Owens bottle machine was introduced, it was urged by the manufacturers of hand-made glass bottles that if the rates for hand-work were reduced at the beginning of the introduction of machinery, the machines would be discarded. The bottle blowers, however, were never willing to accept this opinion, "The Introduction of Automatic Bottle Machines," p. 560.

the rates of the hand-workers affected should not be lowered. Their argument in brief runs as follows: The hand product is usually superior at the beginning to the machine-made article. If the hand-workers compete in price with the machine, the hand rates must be cut again and again as the machine develops its capacity. The result is that the hand product deteriorates in quality and the market for the hand-made goods grows narrower.[6] In none of the cases of the introduction of machinery studied does this particular argument apply, for in all of these cases, the machine product was quite as salable as the hand product.[7]

The proposal to reduce wage rates on hand composition in order to compete with the machine was made during the introduction of the linotype, but the local unions were strongly advised against the adoption of such a policy. In the opinion of the officials of the national union the reduction required would have been so great as to bring the wages of printers below that of unskilled laborers. A few local unions did pursue this policy, but only for a short time.[8] The stonecutters, for the same reason, did not even seriously consider this method of dealing with the problem presented by the planer.

The only one of the unions which systematically pursued the policy of making reductions on hand-work was the bottle blowers, and a review of their experience throws light on the extent to which unions are likely to adopt a similar policy and the consequences likely

6. Webb, "Industrial Democracy," pp. 415, 416.

7. Some newspapers for a time clung to hand composition on the ground of its superiority, but the other advantages of typesetting and type-casting machines over-balanced the advantage of accurate spacing held by hand composition. The machine-made bottle or jar is superior to the hand-made article in exactness of capacity and in finish. Planer-cut stone is not inferior in any particular to hand-cut stone.

8. "The Introduction of the Linotype," pp. 261, 262.

to result. The question was first presented to the blowers when the wide-mouth semi-automatic machine for making fruit jars was introduced. The greater part of the production of these jars was in the hands of a few firms, and of these all except one had introduced machines. This particular manufacturer started one of his plants with non-union men. The officials of the union rather than lose control of the other plants, with the full agreement of the workmen concerned, reduced the rates forty-five per cent. The next year the manufacturer introduced machinery.[9]

When the Owens machine was introduced, the officers of the union resisted for several years all proposals to reduce piece rates for handwork, but in 1909 reductions were made. From that time on, the policy of the union was to reduce hand rates on ware made also on the machine, but to maintain rates on bottles which the machine was not capable of making. But this policy was not adopted willingly. It was forced on the union by the threat of the hand manufacturers to break with the union if the concessions were not made.[1] If the manufacture of glass bottles had been sufficiently specialized so that the manufacturers producing ware competing with the machine had been distinct from those producing ware not so competing, the union probably would have refused to grant the reductions. But this was not the case and if the union had refused, it would have lost control not only of the ware competing with the machine product but also very largely of the ware made only by hand.

The experience of the glass bottle blowers in reducing rates to meet the competition of the Owens machine reinforces the opinion that a reduction in the rates for

9. "The Introduction of Semi-Automatic Bottle Machinery," p. 353.
1. "The Introduction of Automatic Bottle Machines," p. 560.

hand-work is likely to be ineffective in meeting machine competition. Within a comparatively short period, the ware on which the reductions were made was lost to the hand plants. During the interval, however, more bottle blowers were employed than would have been employed if the reductions had not been made. In the reduction of hand rates on glass bottles, one factor not ordinarily present operated in favor of a larger salvaging of skill than would usually accrue from such reductions. The right to use the Owens machine was granted to only a few manufacturers, each of whom specialized in a special line of ware. These manufacturers centralized their production in large plants. The smaller and more scattered hand plants in some cases had advantages in their proximity to the purchasers of bottles, which partially overcame the lower production costs of the Owens plants. Moreover, the licensees of the Owens Company were reluctant to enter into destructive competition with the hand plants. But even with these advantages, the policy was not successful in salvaging any large amount of skill.

It is not, however, to be assumed that the reduction of rates to meet machine competition is to be condemned under all circumstances. Theoretically, situations may be conceived in which such a policy might be justified, particularly if the only aim of the union were the prevention of displacement from the trade. For example, if the machines were confined to a small part of the work of the trade and the margin between hand and machine cost were small, a policy which combined complete stoppage of inflow into the trade with moderate reductions in prices until the workers in the affected sections could be drawn off into the non-affected sections, might very well result in preventing displacement from the trade.

Practically, however, the difficulty which the union faces is its inability to gain exact knowledge of the facts sufficiently to forecast the trend of events. Moreover, since the union is interested primarily in preserving standards of employment, and since reductions on part of its work are likely to be followed by reductions elsewhere, the policy of lowering wages to compete with the machine is not likely to be adopted except as a measure of preservation.

(3) The policy of demanding the employment of hand-workers as machine operators at rates of pay equivalent to those paid hand-workers has been urged by some writers as the primary defence of trade unions against the ills which usually follow the introduction of machinery. This policy has three advantages. In the first place, the amount of displacement from the trade will be reduced to the extent that hand-workers are employed as operators. Secondly, the danger of a surplus of skilled men is to the same extent avoided. Thirdly, the control of the union is maintained over the entire trade. This policy, therefore, unites in high degree the two aims of the unions — to maintain standards and to lessen displacement from the trade.

The extent to which displacement may thus be avoided is obviously in inverse proportion to the displacing power of the machine. Where the displacing power is low — say one to four — the employment of the hand-worker as machine operator, particularly if accompanied by some increase in the demand for the article made on the machine, may go far to reduce displacement. These conditions were present in the introduction of the linotype. Where, on the other hand, the displacing power of the machine is high, the requirement that the machine shall be operated by hand-workers is not important as a means of avoiding complete

displacement, since the number of hand-workers who would be absorbed as operators is not large enough materially to affect the result. It would not have lessened the displacement of the bottle blowers very much if skilled blowers had been employed on the Owens machine. The same was true of the stone-planer.

Even, however, where the absorption of hand-workers in the machine process is not large, the union may be desirous of securing control over the machine operators, since it will thereby retain control over the entire trade. The union may even secure this control without obtaining any advantages in lessening displacement. Where the union is strong, the employer may be willing to concede union jurisdiction over his machine operators, but may be unwilling to agree to pay a wage high enough to place hand-workers on the machine. Under these conditions, control over the machine is secured, but nothing is done toward reducing the amount of displacement.

The chief question with reference to the policy under consideration relates to the extent of its practicability. In some discussions of the subject it is assumed that the enforcement of the rule requiring the employment of hand-workers as machine operators at rates equal to those paid for hand-work is dependent only on the strength of the union.[2] The great importance and success of this policy in the introduction of the linotype

2. See, for example, the testimony of Mr. Samuel Gompers before the Industrial Commission (Report of the Industrial Commission, vol. VII, p. 615). Mr. Gompers apparently regarded himself as the originator of this policy. In his autobiography, he says: "My office was directly opposite the offices of the International Typographical Union on the same floor. William V. Prescott was then president. It was the time of the introduction of the Mergenthaler typesetting machine in the printing trades. The union had not determined its policy. Again and again, I talked through the problem with Prescott urging him strongly to advocate a policy of not opposing labor-saving machinery, but to plan so that the workman could control the use of the machine through

are well known, and it has been argued that this success was due to the ability of the Typographical Union to force the employment of hand-workers as machine operators.[3]

In the previous chapter an analysis was made of the conditions which determine the profitableness of placing hand-workers on machines as operators. It was there shown that the outcome in the cases of the introduction of machinery examined corresponded with the incidence of these conditions.[4] An examination of the policies of the unions concerned with reference to the employment of hand-workers confirms the conclusion that when these conditions are strongly adverse, they are too potent to be overcome by trade union action. All the unions were strong unions, but in only one instance — the introduction of the linotype — was the employment of the hand-workers secured at wages equal to those formerly received by hand-workers. The bottle blowers obtained jurisdiction over the operators of the semi-automatic bottle machine, but only at a lower wage rate than that of hand-workers. Some hand-workers did take employment on the machines, but

the union instead of permitting the machine to control the printers. The wisdom of the printers in dealing with the issue gave the union a strategic advantage in the development of the printing industry." (S. Gompers, Seventy Years of Life and Labor, p. 373.)

3. Professor John R. Commons in an article in the Outlook of November 1906 (reprinted in Labor and Administration) says, "Perhaps no mechanical invention has worked a greater revolution than the invention of the linotype in the printing trade. It has increased the speed of the operator fivefold. But it made possible a three-months' apprenticeship of girls in place of a three-years' apprenticeship of boys. Yet this substitution did not occur in union offices, because the Typographical Union was able to prevent the introduction of women." (Labor and Administration, p. 127.) The argument in favor of the view that the success of the Typographical Union in securing the exclusive employment of hand compositors as linotype operators was due primarily to the profitableness of using compositors as machine operators is fully set forth in "The Introduction of the Linotype," pp. 270–273.

4. Q. J. E., vol. XL, pp. 129–132.

the number was relatively small. The greater part of the operators were recruited through a special machine apprenticeship.[5] In still another instance, that of the flow and feed device, the union secured employment for its members on the machines, but at wages which were not much above those of unskilled workers. The unprofitableness of employing skilled bottle blowers on the Owens machines was so obvious that the bottle blowers made no attempt to secure their employment.[6]

It may be concluded that the policy of requiring the employment of hand-workers as machine operators at wages equal to that of hand-workers is one to be carefully explored by a union at the time of the introduction of machinery, but that it is not a policy which is generally practicable. If a large surplus of men in the trade has been caused by the introduction of the machine, the union may wish to secure the employment of hand workers on the machines, even tho the skill of the hand-worker is not of great value in the operation of the machine, and the rate of remuneration not much higher than that paid for unskilled labor.

(4) The device of directly checking inflow into the trade and thus reducing the amount of displacement during the period of the introduction of machinery can be used effectively by a union only when the national union controls the number of apprentices. This is rarely the case in American trade unions, where this power, when exercised by the union at all, is almost always in the hands of the local unions. In the cases of the introduction of machinery studied, only one of the national unions concerned — The Bottle Blowers — at the time of the introduction of the machine, regulated the number of apprentices by national agreement.

5. "The Introduction of Semi-Automatic Bottle Machinery," p. 344.
6. "The Introduction of Automatic Bottle Machines," pp. 562, 563.

Unfortunately for the successful working of this device in the bottle trade, the union and the manufacturers had for many years maintained a system of apprenticeship under which the apprentice was paid much lower piece rates than a journeyman for the same work. The employers were, therefore, reluctant to yield anything in the number of apprentices. Although it was not until comparatively late in the introduction of the Owens machine that the rates received by apprentices were increased, the union was able, by making concessions in wages, to secure reductions in the customary ratio, with the result that the inflow was reduced greatly. Even as it was, many of the apprentices taken from 1908 to 1912 simply increased the number of workmen later forced from the trade. Where it can be used, the direct limitation of the number of apprentices is the most effective device for lessening displacement possessed by trade unions.

In the previous chapter, it was argued that if the mobility of the workers in a trade were sufficiently great — in the absence of any special incentive to the taking of apprentices — the inflow into the trade would cease when there was a surplus of trained men, since employers ordinarily do not profit by training new workers. The promotion of mobility may be regarded, therefore, as an indirect method of checking inflow into the trade. The introduction of machinery is almost always gradual, and a high degree of mobility would make it possible to decrease largely displacement from the trade by the transfer of hand workers (*a*) from the affected branches of the trade to those still unaffected or (*b*) from hand-work to machine work, in those cases where the hand-workers are employed as operators of the new devices.

The most important attempts at promoting mobility

found in any of the cases of the introduction of machinery studied were those made by the local unions of the Typographical Union at the time of the introduction of the linotype. The national union had established a rule that only journeymen printers could be employed as linotype operators, but it refused to rule that each office must recruit its operators from its own staff of journeymen printers. In the interest of preventing inflow into the trade, it was desirable that operators should be drawn as far as possible from their immediate locality. Otherwise vacancies would have been occasioned in the localities most drawn upon for operators and an inflow of apprentices would have been caused. In order to bring about, as far as possible, local recruitment of operators many of the local unions organized schools for training operators. Also they secured from many employers an agreement that operators should be recruited from the office force. Almost always the local unions granted a reduction in wages during the period of training as a linotype operator.[7]

None of the unions in the trades studied attempted to promote by any organized means, the movement of hand-workers from affected branches of the trade to those still unaffected. To have accomplished this would have necessitated either the setting up of some means of retraining the hand-worker to fit him for another branch of the trade or some concession in wages to employers during a period of training. The first method would have involved a considerable outlay and the second, the possibility of menace to the standard rate.

However desirable mobility from the affected to the unaffected branches of a trade may be as a means of avoiding displacement, the union incurs a risk in promoting it. If the advance of the machine is rapid and

7. "The Introduction of the Linotype," pp. 260, 261.

the mobility of the workers in the affected sections of the trade is great, the unaffected sections will soon be over-crowded. A displaced man, who needs aid to make him available, is not a menace to the trade; an army of displaced men made available by training to take the places of men already employed would be a serious problem for the union to face. Since the union is primarily concerned with the maintenance of working conditions, it is not remarkable that efforts in the direction of enhancing mobility have been confined to those required to extend control over the machine process.

(5) The policy of distributing the available work as widely as possible during the period of strain accompanying the introduction of machinery recommends itself to a trade union both as a means of salvaging skill and as a means of lessening pressure on the union's standards. If the number of surplus workmen is not large, a distribution of work may be carried out without materially lowering individual earnings. Whether such a distribution of work is desirable in order to protect standards of employment depends upon whether the displaced hand-worker is in a position to affect materially by his competition the standards of employment in the trade. Theoretically, therefore, the union would be interested in such a distribution of work chiefly when the displaced men constitute a menace to the maintenance of standards. Practically, it is impossible when machinery is being introduced to foresee how displacement will affect the conditions of employment, and the attempt to effect some distribution of work as a precautionary measure is almost certain to form a part of the union's policy. In the cases studied, the distribution of work was attempted in three ways: (*a*) by rotation in employment, (*b*) by reducing working

time and (*c*) by the introduction of the three-shift system.

(*a*) In some trades, the conditions are such that a full force of workmen is necessary. In a newspaper office, for instance, a certain number of compositors must work if the newspaper is to be published at a fixed hour. Glass bottles when made by hand are manufactured ordinarily by a shop consisting of three workmen, one of whom finishes while the other two blow. If one of the members of the shop is absent, the output is cut in half. Both in newspaper offices and in bottle factories, therefore, it has been customary to employ other workmen to fill the places of compositors and blowers who were absent. In both unions, the choice of a substitute is made by the workman whose position was filled. It was possible, therefore, for the workmen to distribute work during the period of the introduction of machinery.

The printers made much more of this possibility than the bottle blowers. In both unions there was a widespread sentiment that the unemployed should share in the available work, and there was in both unions a considerable amount of voluntary laying-off on the part of the employed in order that the unemployed might share in the work. In the Typographical Union the matter was not left entirely to sentiment, but many of the local printers' unions adopted rules limiting the number of days a "regular" might work in order that "substitutes" might be employed.[8] Among the bottle blowers the matter of "lay-offs" was left entirely to the individual workman regularly employed. The comparatively small interest in this device among the blowers was due to a difference in the character of the invasion of the machine. The introduction of the lino-

8. "The Introduction of the Linotype," p. 263.

type was local in that there always remained in employment in the locality a number of hand compositors. The bottle machines not infrequently completely displaced all the hand blowers in a particular locality. In neither union was the sharing of work a large factor in salvaging skill. It did, however, serve to tide some of the men over a difficult period.

(*b*) A reduction in the hours of the hand-workers naturally suggests itself to a union as a remedy for a surplus of workmen. This policy formed a cardinal part of the program of the printers with reference to the introduction of the linotype in newspaper offices. Fortunately, the newspaper publishers were desirous of securing an increase in their ability to set matter in the last few hours before going to press. Under the conditions prevailing before the introduction of the linotype, they were unable to do this except at great expense. With the cheaper cost of machine composition, they did not oppose seriously a shortening of hours for machine operators from those formerly prevailing for hand compositors. Since the office works as a unit, this carried shorter hours for ad-men, proof-readers, make-up men and other coöperant hand-workers.[9] Neither of the other two unions included in the present study was able to use the device of a shorter work-day as a means of avoiding to some extent the effects of the introduction of machinery. The stonecutters were already working relatively short hours, and technical conditions led the bottle blowers to attempt to reach the same end by means of the three-shift system.

(*c*) At the time the Owens bottle machine was introduced, the bottle hand plants ordinarily worked two shifts of eight and one-half hours. The employers were strongly opposed to a reduction in the total time worked,

9. "The Introduction of the Linotype," pp. 264, 265.

as cost of fuel and other overhead expenses would be increased. To meet this situation, the president of the Glass Bottle Blowers' Union evolved a plan for working three shifts, under which the working time of each shift was to be reduced a full hour. Also, the three-shift system in another way, was expected to be an effective means of distributing work more widely. Since a bottle factory while in operation must have men for all its shifts, the existing factories could have absorbed an additional number of workmen equal to fifty per cent of the former force. The factories would not have run as nearly continuously through the year, but the work would have been more evenly divided.[1] The plan was adopted to some extent, but not widely.

The experience of the three unions indicates the difficulties likely to be met in any attempt to distribute work more widely during the period of introduction of machinery. It seems clear that except under very unusual conditions, this device is not likely to be of much effect in reducing the amount of displacement, but as a temporary expedient to relieve the stress of the transition period, it has proved valuable.

The general results of the introduction of machinery in the trades studied may be briefly recapitulated as throwing light on the effect of trade-union action on displacement of skill. The effect of the linotype in displacing workmen from the trade was very small, especially after the early period. The displaced men were chiefly elderly printers who were unable to adapt themselves to either machine work or any of the coöperant processes

1. "The Introduction of Automatic Bottle Machines," pp. 554–556.

required in machine offices. The wages and hours of the hand-workers were steadily improved during the period of introduction. Similar results followed the introduction of the semi-automatic bottle machine. The field of invasion here was small relatively to the total trade. A few bottle blowers were displaced, but they were chiefly those who could not accommodate themselves to the other branches of the trade or were unwilling to move to places where work at those branches could be obtained. The conditions of employment were not unfavorably affected; on the contrary, the wages of hand-workers were increased and the hours of labor shortened during the period of introduction fully as much as in kindred trades.[2]

The introduction of the stone-planer was accompanied by far less favorable results. Probably one half of the stone-cutters in the United States were displaced from the trade between 1900 and 1910. The wages and other working conditions in the trade, however, were only slightly affected. The increase in the wages of stone-cutters in this period, one of generally increasing wages, was less than that in some other trades of kindred character, but not materially so.[3] Far more disastrous were the results to the bottle blowers from the introduction of automatic bottle machinery. From 1907 to 1924 the number of blowers and operators of semi-automatic machines decreased from nearly 10,000 to about 1500; in the same period the wages of both these classes of workmen lagged far behind wages in other trades. The bottle blowers advanced their wages very little during this period, while the great mass of American labor more than doubled its wages.[4]

2. "The Introduction of Semi-Automatic Bottle Machinery," p. 754.
3. "The Stonecutters' Union and the Stone-Planer," pp. 441–443.
4. "The Introduction of Automatic Bottle Machines," pp. 563–566, 571–573.

Are these great differences in the amounts of displacement from the trade to any considerable extent explicable on the basis of differences in trade-union policy? It is very doubtful. In the preceding chapter it has been indicated that displacement from these trades agreed roughly with the nature of the mechanical and economic factors which centered around the introduction of the particular machines, and the foregoing study of trade-union policy indicates that these factors are controllable by trade-union action within only very narrow limits.

The effect of differences in trade-union policy on the wages and other conditions of employment of the skilled workers left in employment is a more debatable question. In the foregoing review of the effects of the introduction of machinery, it will have been noted that the stonecutters suffered very little in the matter of wages while the bottle blowers were unable to keep the wages of hand-workers on an equality with wages in similar trades. Was this difference due to the policy of the bottle blowers and in particular to their action in reducing the price of articles made on the machine? From one point of view, the answer is in the affirmative. If the bottle blowers had been able to maintain the hand price on articles made both by hand and on the machine, the hand plants would have been forced sooner to abandon the manufacture of those articles. The result would have been an earlier disappearance of the surplus of men in the trade and an earlier upward movement in the wages of hand blowers. This is not, however, to say that the policy of the blowers was inferior to that of the stonecutters. The difference in policy was not due to deliberate choice, but to the difference in the conditions confronting the two unions. The stonecutters are employed by master stonecutters who

work on contract, and with a comparatively small investment in equipment. The stonecutters, powerfully aided by the other unions in the building trades, were able to enforce their rates, even in the presence of a large surplus of displaced men. The situation of the bottle blowers was quite different. Their employers had heavy investments in equipment which would have been rendered in large part worthless unless the rates for making bottles was reduced. It was the pressure of these employers, who otherwise would have broken with the union, that forced the blowers to make the reductions.

The most important consideration in determining union policy is the surplus of men in the trade caused by the introduction of machinery and the power of that surplus to affect conditions. A great surplus of stonecutters disappeared rapidly without any markedly injurious effect on working conditions. One of the most striking facts in the history of the introduction of machinery in the glass bottle trade also has been the rapidity with which a surplus of hand blowers became innocuous. It was the rapidly successive introductions of the machine into the various parts of the trade, each of which created a new surplus, that constituted the characteristic difficulty of the bottle blowers in the introduction of the automatic bottle machines.

From the foregoing, two general conclusions may be drawn: (1) The unions have been far more successful in preventing reductions in the wages of the hand-workers left in employment by the machine than in lessening displacement from the trade. This is partly due to the fact that the maintenance of working conditions has been the primary aim of the unions, but it is chiefly due to the fact that the amount of displacement from the trade is determined by factors almost entirely beyond

the reach of union policy. (2) The policies to be followed by a union during a period of introduction of machinery cannot be stated dogmatically. There are no policies of universal validity. In any particular case of the introduction of machinery, sound policy must be derived from a knowledge of the mechanical and economic factors involved, together with some estimate as to the effect of the surplus occasioned in the trade by the introduction of machinery on the conditions of employment.

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INDUSTRIAL INVENTION: HEROIC, OR SYSTEMATIC?[1]

SUMMARY

I. Purpose of this paper: to survey the literature, to examine current practice, and to classify the facts needed for a tenable theory, 233. — II. The heroic explanation, commonly found in biographies, 237. — Inventive abilities not so rare as commonly supposed, 241. — III. Theories of successive increments, 242. — Cumulative character of contribution and discovery, 243. — This intensified by our greater willingness both to accept and to give, 251. — IV. Organized industrial research and invention on the part of large corporations, 253. — Methods by which new devices are developed, 255. — Coöperative character of the procedure, 258. — V. Materialistic explanations, 260. — The profit motive not so essential in some instances as in others, 266. — The real question: what proportion of usable inventions comes from professional inventors? 268. — VI. Conclusion: what sort of inductive study is needed, 269.

As a result of the restriction of immigration, considerable attention has of late been directed toward what may be called the mechanization of industry. It is frequently asserted that the relative shortage of unskilled labor is to be met by the increased utilization of machinery. Not men, but mechanical equipment, not muscular force, but steam, electric, or other power, must perform the various tasks for which the horde of immigrant labor has been relied on in the past.

A recent conference of economists and business men considered ways and means of meeting this problem.

1. For valuable aid and suggestion in the preparation of this paper, I am indebted to the following persons: Professors E. F. Gay, F. W. Taussig, A. A. Young, and W. J. Cunningham; Henry S. Dennison, M. M. Bober, Evelyn Gibson, and Elizabeth L. Waterman. The heaviest of these obligations are to Professor Gay, at whose suggestion and under whose direction the study was undertaken, and to Mr. Dennison, who coöperated generously in parts of the investigation concerning current industrial practices.

The discussion dealt, however, wholly with the financial aspects of obtaining the new and greater investments of capital equipment. No word was said as to the conditions under which the new mechanical devices themselves might be developed. The assumption was simply that, granted economic demand, granted the possibilities of the capital expenditure, the appropriate contrivances would be at once forthcoming.

It is the purpose of this paper to inquire how far this faith is warranted. What actually *are* the conditions of invention? Do economic and commercial needs unfailingly bring forth new mechanical or other devices to meet them? If so, are these devices forthcoming immediately, or must a considerable period elapse before they emerge full-fledged? If the "making" of inventions does require time, then why is this period shorter in some instances than in others? And are there any instances in which insistent calls for a device, coupled with deliberate and persistent efforts to achieve its design and manufacture, have not successfully met the needs? On the other hand, take certain inventions which have not been "made to order." Clearly there are many such inventions contrived, not at the behest of a manufacturing company or an engineering firm attempting to solve a particular and immediately present problem, but simply because the general desirability of such devices commends itself to the inventor. There may exist in most instances, to be sure, a need for the invention, some thoroly practical use to which it may be put, but the specific necessity is more or less remote—at any rate, is much more so than in the case of inventions made to order. What then are the conditions of discovery and advance, of stimulation and development?

In any cases or in all, what are the motives which

underly the making of inventions? What has been the effect historically, say, of the patent system upon the mainsprings of inventive action?[2] Or do much inventive activity and discovery take place independent of pecuniary reward? Is there any justification for saying that in the modern industrial system there exist not alone inventors, but an *organization* for inventions — a group of technologists and specialists, with a body of scientific and practical formulae and facts at its disposal, whose continual activity causes inventions constantly to pour forth, quasi-independent of the offering of large prizes or special allurements to any one man?

To answer these questions — as well as various others which might be put and will be suggested later — we should have to know numerous facts about both inventions and their contrivers. Who, for example, are the inventors? Mainly men of science? Mainly men engaged in applied science (engineers)? Mainly artisans or superintendents in the employ of industrial concerns? Mainly men not engaged at all in the economic field to which their contribution was made, but in some

2. There has recently been published an interesting work by Floyd L. Vaughan, Economics of our Patent System, in which this matter is considered at some length, for the United States. His conclusion is that while "no attempt is made to assign different degrees of importance to the causes of invention . . . the desire for economic reward appears as one of the most frequent and important causes. . . . Patents furnish the means by which the expectation of pecuniary gain may be fulfilled, and to this extent promote the progress of the industrial arts and the welfare of society. In return for this advantage, the people grant to the inventor . . . the right to exclude others for seventeen years from making, using and selling his invention." (pp. 32, 33). Vaughan adds, however, that "The evils connected with our patent system reduce his patent in most cases to a mere deception" (p. 249). He suggests that one thing which is needed is "a governmental investigation of certain practices arising from patents . . . which would permit the collection of statistical data which are beyond the reach of the individual investigator" (p. 249). It is obvious that the efficacy of any such governmental action would depend almost wholly upon the personnel of the investigators.

other trade or pursuit? Mainly men who pursue the business of invention as an avocation? Mainly professional inventors — men so enamoured by the business of inventing that they can do nothing else? Or, mainly professional companies, such as engineering firms, safety-device companies, machine-tool factories, or commercial laboratories? And what is the connection — direct or indirect — of these various inventors with the science and "pure learning" of their generation?

Again, assuming that these facts could be obtained, would they be different for the decades 1900–1920 and for the decades 1760–1780, or for, say 1820–1840? In other words, as the conditions of the industrial arts and the sciences are altered, do the conditions of invention become altered also? Or is the difference only a quantitative one — a greater or smaller output of inventions made in one period as contrasted with another, quite apart from the relative ease or difficulty of the making? And do the later inventions constitute a more or less revolutionary set of discoveries and contrivances with respect to their industrial significance? It is often asserted, for example, that the industrial inventions of the last few decades, say 1890–1920, are much less epoch-making in their efforts than those of earlier periods; and it is further often alleged that all the changes in methods of production — so far as regards technology — which are revolutionary in character have been achieved; that a relatively slower rate of advance alone can be hoped for in the future. But if inventions can more or less freely be made to order, we may well ask why this should be so, and whether the revolutionary period of industrial discoveries does certainly lie in the past.

Another observation sometimes made on manufactures holds that of the two sets of economies designated

by Marshall as internal and external, the former type — savings effected by the cheapening of production processes within the plant — is becoming relatively less important, and the latter type — savings brought about by the growth of certain industries generally — relatively more so. The first set is supposed to be more dramatic, but more irregular in its action; the second, external economies, is supposed to be less striking in specific instances, but steadier in its operation, and its aggregate effects more far-reaching. Whether this view is now justified is open to serious question. In the industries which make mechanical or complex fabricated products — for example, automobile manufacturing — it is somewhat doubtful which set of economies has been the more important in reducing costs. Certainly now, when the producers of "assembled cars" are for the most part left far behind in volume of production, and when the integration of processes is taking place more and more among the larger companies, economies achieved *within* the enterprise appear increasingly to be playing a major part. The evolution of the stages that have been gone through in automobile parts-making would itself constitute an interesting study.

Could data bearing on the foregoing questions be compiled, valuable light might be obtained upon the influences affecting the course of invention. It is not the purpose of this paper to present all or even any considerable part of the materials thus needed, but merely to accomplish two things: first, to set forth a critical summary of certain theories of invention which are found in economic, engineering, and biographical literature;[3] secondly, to furnish a definite schedule of

3. There are also passages concerning inventions in the writings of certain sociologists, altho these materials consist for the most part merely of casual observations made in the course of considering some other more general topic. Lester F. Ward's Psychic Factors of Civili-

the kinds of facts which seem to be needed before any comprehensive theory can be built up. Into the discussion will be interjected such sporadic facts and bits of evidence bearing upon these theories as have come to the writer's attention in the course of his study. These new facts, it is hoped, will serve to illustrate, and in some slight measure to appraise, some phases of the one or the other theory under survey. Before anything more definite can be accomplished, both further historical research and additional investigation of the current industrial situation are required.

II

When one man is given complete or practically complete credit for a particular invention, when that invention is conceived to have flashed virtually from his brain alone, or to have been worked out by him as a result of his peculiar inspiration or genius, we have what may be termed an "heroic theory" of invention. Such accounts of the course of invention are commonly

zation, cited below, is an exception. Valuable passages bearing on the problem are also to be found in the writings of some anthropologists, notably Franz Boas, The Mind of Primitive Man. Another anthropological work, of value for the genesis of simple tools, etc., is O. T. Mason, Origins of Invention. Johann Beckmann, Beiträge zur Geschichte der Erfindungen (5 vols., 1782–1800; Eng. Trans., 4 vols., 1797–1814) is useful chiefly for descriptive materials and dates; it contains little in the way of interpretation. A recent work, chiefly narrative in form but of decided interest, is A Popular History of Inventions, edited by Waldemar Kempffert. E. W. Byrn, The Progress of Invention in the Nineteenth Century, (1900), describes the important developments in various fields of industry. A. DuBois-Reymond, Erfindung und Erfinder (1906), is a philosophical discussion, with some reference to German patents. Of biographies of inventors there are many, but Smiles' Lives of the Engineers still remains one of the best. Babbage's Economy of Manufactures (1832) and a more recent book, J. W. Roe's English and American Tool-Builders (1916), are of value. Of general interest, but not of specific aid are passages in the writings of Carlyle and Buckle. Additional references will be indicated in the course of the discussion.

found in biographies. The biographer makes a hero of his subject and imputes to him qualities of vision and accomplishment which enable him to do what other men, men of lesser mold, can not do. Those who hold the heroic explanation do not deny the influence of necessity and the stimulus of economic needs and conditions. As will be seen shortly, some form of "necessity doctrine" seems to be implied, to a greater or lesser extent, in nearly all theories of invention. What the advocates of the heroic theory always assert or imply is that without the one man whose life they are chronicling, a particular invention could not, or would not, readily have been forthcoming.

As an example of this theory, there may be cited French, the biographer of Samuel Crompton. We are told that when sixteen years old Crompton began to think systematically. His summer evenings were spent in walks through the countryside, all "contemplative" in character. To Crompton's great power of reflective thinking and sustained attention, French attributes the invention of the spinning-mule. And not only was Crompton a thinker: he is said to have possessed an especial "knack" for invention. There is in French's biography no suggestion that the spinning-mule would ever have been invented had Crompton not lived. After reviewing the effect of the industrial revolution upon life in England, French concludes as follows: "Many great and active minds have been at work to produce this unprecedented result [the modern machine régime]; but to *one*[4] more than to all others collectively it is due. It was the mind of Samuel Crompton, which, under Providence, vivified this crowded area — the man (we state it advisedly) who has been the means of diffusing more material good over the surface of this globe than

4. Italics are French's.

any other human and uninspired being that ever dwelt upon it." [5]

Similarly Smiles, the famous biographer of the engineers, not only asserts that James Watt was "emphatically well born," [6] but in another work states that he "was a thinker from his cradle." [7] Watt, the man, is made the hero of the discoveries connected with his name.

Numerous other illustrations of the heroic theory could be presented. It is to be understood, of course, that few of these explanations exist in unadulterated form. Most of the theories which impute the major credit for inventions to the genius of particular individuals qualify the heroic explanation somewhat by taking cognizance of the aid which the inventors may have received from others. Yet in spite of these admissions it does not seem an overstatement to say that the heroic theories of invention, found mainly in biographies, stress the contribution of some one person in the case of each invention and discovery; and assume that the presence of this person's peculiar genius was indispensable to the production of the invention in question.

To criticize a theory of this character in any adequate fashion would obviously require, for one thing, more knowledge than we now possess concerning the relative effects of heredity and environment upon the individual. Certain persons are exceptionally prolific of inventions. We know, for example, that over forty individual inventors obtained more than 100 patents each from the United States Patent Office during the period 1872–1915.[8] We know further that many inventors have

5. Life and Times of Samuel Crompton, pp. 233, 234.
6. Lives of the Engineers, vol. iv, p. 79.
7. Life and Labor, p. 116.
8. High up in this list were the following: Thomas A. Edison, 977; Francis H. Richards, 847; Elihu Thompson, 617; Charles E. Scribner,

manifested traits of curiosity, wonder, and a tendency towards experimenting or contriving relatively early in life. From facts such as these, it is often inferred that certain men possess at birth a much stronger latent capacity in these directions than do most persons. The validity of any such conclusion cannot be definitely established; it is impossible to disentangle the influences of environment and those of heredity. But a few instances of grounds upon which such inferences are based may be cited.

So strong in Edison was the urge of curiosity, it is said, that when as a boy of twelve he observed the manner in which hens lay eggs, he himself obtained some eggs and attempted actually to hatch them; and then wondered why he could not so do.[9] And at the same age, Frederick W. Taylor, Birge Harrison relates,

> was troubled with very fearsome and terrifying nightmares. Being of an observant nature, he soon noticed that when he awoke from one of these obsessions he was invariably lying on his back — and from this he argued that there must be some connection between the position in which he lay and the distressing mental disturbances. Thereupon he constructed for himself a sort of harness of straps and wooden points, the latter so arranged that whenever in his sleep he turned over on his back the points in question would press the dorsal muscle and at once awaken him.[1]

Many more such examples of "inventive genius" could be given; the biographies are replete with them.

437; George Westinghouse, 340; Edward Weston, 299. The Encyclopedia Americana, article on Inventions. This article contains a list of the great inventions that have been made in all countries; but this list is neither comprehensive, nor entirely accurate as regards many of the dates and names included.

9. Dyer and Martin, Edison — His Life and Inventions, vol. i, p. 17.

1. Quoted in F. B. Copley, Frederick W. Taylor, Father of Scientific Management, vol. i, p. 58. Harrison also writes that, "Even a game of croquet was a source of study and careful analysis with Fred, who worked out carefully the angles of the various strokes, the force of impact, and the advantages and disadvantages of the under-stroke and over-stroke, etc. It was inevitable, of course, that this passion for invention should have been very early developed."

It should be noted, however, that of the credible incidents related by many a biographer concerning his subject's childhood inventions, a number are such as have occurred in the lives of many persons; in point of frequency of occurrence, they are thus not at all remarkable. Who, for example, has not thought of how convenient it would be to have a pulley-and-cord arrangement reaching from bed to window on a chilly morning? And similar, less obvious contrivances for other purposes have occurred to almost all of us. Some we have actually constructed; others not. It is true that the discovery of new scientific principles may seldom be involved in the devising or the construction of such contrivances. There are, none the less, new ways of doing things through utilizing other than direct, unaided manual forces; and while not physical, electrical, or chemical discoveries, they do constitute mechanical or other inventions.

All of which is merely to remark that while inventive genius may be rare, inventive ability is by no means so uncommon as is often supposed. As to what proportion of our important inventions may come primarily from the socalled "inventive geniuses" or "professional inventors," something will be said below. But that the mere devising of new ways of doing things and new contrivances for doing them is not at all alien to the propensities of most persons, is shown by the results obtained by the suggestion systems so current of late in our stores and factories. Each day, improvements are suggested by workers, and a goodly number of these are accepted. The Dennison Manufacturing Company, for example, employing about 3,000 men, received from its employees in the one year 1920 a total of 3,701 suggestions, 50 per cent of which were of a mechanical nature. Fifteen per cent of all the sugges-

tions received were adopted by the company. The proportions are not the same each year, but the absolute numbers are appreciable.

III

Quite opposed to the heroic theory (even as qualified) held by most biographers are the views of a number of historians, psychologists, and economists. These emphatically assert that no single man, even if he is a genius, is responsible for the sum total of his abilities, and for the overt acts and accomplishments in which his abilities become crystallized. To the society and the generation into which he is born and lives, the inventor owes a debt that stretches back to the life of other generations which have preceded. Thus regarded, a given invention is merely the culmination of a train of efforts reaching back into the past and brought to fruition in the present.

The history of the steam engine furnishes an example of such a process of successive development.[2] From the Aeopile of the Greeks (Hero's Engine or Ball of Aeolus, B.C. 200), which was nothing more than a water cauldron with a globe suspended above it on two hollow trunnions, through which the steam passed and revolved the globe, to the separate condenser engine of Watt in 1759, was a period of centuries, the last of which witnessed writings and experimentation by many men. Among them were Matthesius (1451), Besson and Bervaldus (1518), Ramelli (1588), Porta (1601), De Caus

2. See R. H. Thurston: A History of the Growth of the Steam Engine; also the same author's A Manual of the Steam Engine, and Philosophy of the Steam Engine; C. Matschoss, Geschichte de Dampfsmaschine; and the works of J. Kulischer and Max Weber cited below. Both Kulischer and Max Weber give interesting accounts of the economic necessity, in coal mining in particular, which brought about the technical development.

(1605), Worcester (1665), Huyghens (1650), Papin (1680), Savery (1698), Newcomen (1705).[3] Newcomen's engine, improved by Potter, Beighton, Smeaton, and others, was in fact so effective that it was used for pumping purposes in England and on the continent, all through the eighteenth century and even in the early nineteenth century, long after Watt and Bolton were well established in the engine-building business.[4]

Thus Thurston declares that the history of the steam engine "illustrates the very important truth: *great inventions are never, and great discoveries are seldom, the work of any one mind.* Every great invention is either an aggregation of minor inventions or the final step of the progression. It is not a creation but a *growth.*"[5]

The gas engine, likewise, owes its being to the work of many inventors. Huyghens, Papin, Samuel Brown, W. L. Wright, William Barnett, and others, all antedated Lenoir, who in 1860 invented the first gas engine "ever actually introduced regularly to public use."[6] Immediately following Lenoir, came the contributions of Siemens, Hugon, Otto, and Brayton. "In 1867," says Clerk, "Messrs. Otto and Langen exhibited at the Paris exhibition of that year, their free piston engine. . . . It was absolutely identical in principle with the previous invention of Barsanti and Matteucci, but the details

3. Thurston, History, chapters i–iii. I have omitted many other names which might be adduced and can be found in Thurston.

4. See Jan St. Lewinski: La Revolution Industrielle de la Belgique, pp. 64 ff.

5. Pages 2, 3. The italics are Thurston's.

6. These names and dates are taken from Dugald Clerk, The Gas, Petrol, and Oil Engine, vol. i, chap. 1 (originally published as The Gas Engine) and R. Schöttler Die Gasmaschine, chap. 1. The phrases quoted are from Clerk, page 14. Other historical sketches of the gas engine may be found in Bryan Donkin, Gas, Oil and Air Engines, and Hugo Güldner, Das Entwerfen und Berechnen der Verbrennungsmetoren. In Güldner an outline of the development is given in tabular form on pp. 4, 5.

were completely and successfully carried out." [7] To these names must be added those of Siemens, Atkinson, Daimler, Clerk himself, and still others.[8]

Similarly one may examine the textile trades, the history of which is well known. The cotton industry, in the form in which we now know it, dates back to about 1770. But while this development "must always be attributed in large measure to the inventions associated with the names of James Hargreaves, Richard Arkwright, and Samuel Crompton," nevertheless, adds Daniels, one of the ablest of modern investigators of the industry: "Their inventions represent the *culmination of a series* of endeavors to improve the processes of cotton manfacture which reach back to the thirties of the eighteenth century." [9] The earlier inventions referred to are those of Kay, Paul, Wyatt, and Highs.[1]

We have, then, what may be termed the "theories of small increments." Says Hobson of the same industry: "No one of the inventions which were greatest in their effect, the jenny, the water-frame, the mule, the power-loom, was in the main attributable to the effort or ability of a single man; each represented in its successful shape the addition of many successive increments of discovery; in most cases the successful invention was the slightly superior survivor of the many similar attempts. 'The present spinning machinery which we now use is supposed to be a compound of about eight hundred inventions. The present carding machinery is a compound of about sixty patents.' This is the history of most inventions." [2]

7. Clerk, op. cit. vol. i, p. 20.

8. Schöttler, op. cit. (appendix) gives a list of over 300 patents which were taken out on gas engines in Germany alone up to June 30, 1889.

9. The Early English Cotton Industry, p. 72. The italics are mine.

1. An interesting account of these men is given in the Quarterly Review for 1860, in an article entitled "Cotton-Spinning Machines and Their Inventors."

2. Evolution of Modern Capitalism, Revised ed., p. 79.

The modern gasoline automobile would seem to be another case in point. Any list of inventors who have "made" the gasoline automobile would have to include not only the score or more early developers of the gas engine, but Maybach, Daimler and Benz in Germany; De Dion, Bouton and Krebs in France; Gibbon, Lewis, and Lanchester in England; and in this country, Duryea, Olds, King, Haynes, Ford and Winton,[3] *plus* the Lelands, the Dodge brothers, and a score of other mechanics, machinists, machine-tool and parts makers who coöperated in the development and manufacture of an effective motor vehicle. For it is to be noted that there is a vast difference between a working model and an effective mechanism. Olds's cars, Ford's cars, Haynes's cars, built between 1893–1899, all ran; but it will insult none of these men to say that these cars lumbered along. Charles B. King, pedalling a bicycle, followed Ford's car and picked up the bolts and parts

3. I am indebted to Mr. Robert A. Brannigan for information concerning Krebs, whose activity seems to have been of greatest importance, tho it has been often neglected by writers on the subject.

In the enumeration no pretense to anything that approaches completeness or, indeed, proper emphasis is made for countries other than the United States; I have not examined the foreign development sufficiently to list accurately even those chiefly and directly responsible for the automobile in European countries. But invention along that line proceeded simultaneously with the development here; indeed, for some years after the industry was established in this country, many American designers copied foreign practice carefully and extensively. I have omitted Selden from this list because—altho I have not as yet investigated the situation as thoroughly as I should like—it appears that, while his patent was legally basic, he played little part in the actual construction of any early "horseless carriages." The list also ignores, for all countries concerned, such pioneers as Cugnot (c 1770) and Serpollet (c 1889) in France, Hancock and Gurney in England (c 1830), Oliver Evans (c 1785) and later the Whites and others in America (c 1885–1900), who constructed road carriages propelled by steam. An account of most of these men with pictures of their vehicles, is given in the journal, Motorwagen, 1899, Heft IX: Die Entwickelung des Automobiles, von Dr. A. Neuberger. An earlier account is A. J. Wallis-Tayler, Moter Cars or Power Carriages for common roads (1879).

which fell off on its trial trip.[4] Haynes, erroneously called the "father of the automobile" and builder of "America's first car," [5] made a machine in 1893, but bought most of the parts used in it, including the engine. This was a Benz motor imported from Germany. Olds, Duryea, Ford, and Winton made their own engines and most of the remainder of the chassis; but early in the commercial development and construction of their cars, received aid from a number of outside sources. In the case of Olds, whose "curved-dash Oldsmobile" entered quantity production in 1900, Leland and Faulconer made the motors; Dodge brothers made the transmissions; Briscoe, the radiators and stampings; Everitt, the bodies — it is true, after Olds's designs. Others, however, contributed the designs themselves, to make integral parts or devices utilized in the car. In his early models, for example, Olds, in common with other engine builders, employed a hot tube to ignite the charge in the cylinder, until an electrocutioner at Sing Sing devised a mechanism embodying the spark-gap principle, about which he wrote the automobile maker.

That no invention is dependent upon the presence of any one individual is likewise the view expressed by Ogburn and Thomas.[6] who offer a list of 148 inventions

4. This, I am told, is literally true. It is also of interest to note that one of Olds's early models snapped its axle shaft during a demonstration which Olds was making in order to obtain funds to build another car. Fortunately for the immediate continuance of mechanical experiment, a slight down grade happened to lie ahead around a corner. The car went to the corner under its own momentum, and then coasted to the shop door, where the prospective customer alighted and completed the transaction by signing the necessary papers.

5. It seems probable, from the evidence which I have so far examined that others have as good a claim as had Elwood Haynes to the construction of the first American gasoline car, and that one, Charles E. Duryea, has a better one. Certainly Haynes, though entitled to great credit as a metallurgist, early inventor, and pioneer manufacturer, is hardly to be regarded as the "father" of the automobile in any special sense.

6. "Are Inventions Inevitable?" Political Science Quarterly, March 1922.

and discoveries, each one of which was discovered by two or more persons practically simultaneously, each person working independently of the other; a list whose compilation makes a real contribution to the study of the subject. These writers suggest that a particular invention is a matter of general societal culture and scientific preparation and development, rather than of the abilities of any one, or sometimes even any two or three specific individuals. "It would be an absurdity to conclude that, even if he [James Watt] had died in infancy, the Industrial Revolution would not have occurred."

Some modern simultaneous inventions from this list, of perhaps chief immediate importance for the development of industry and commerce during the last century, are as follows:

Telephone (Bell, 1876; Gray, 1876).
Sewing Machine (Thimmonier 1830; Howe 1846; Hunt 1840).
Reaper (Hussey 1833; McCormick 1834).
Steamboat (Jouffroy, Rumsey, Stevens, and Symmington, 1802; Fulton 1807).
Typewriter (Beach 1847–56; Wheatstone 1855–60).
Trolley Car (Van Doeple 1884–85; Sprague 1888; Siemens 1881; Fact 1883).
Gasolene Automobile Engine (Otto 1876; Daimler 1885).

In their discussion of the significance of these facts, Ogburn and Thomas posit two factors in the making of inventions: (1) the distribution of "mental ability" in the population, (2) "the existing status of culture." The first, they suggest, resembles the normal probability curve; and is practically invariable over a period of time. The second is "obviously highly variable, particularly in the last few centuries."

A full discussion of this doctrine cannot be undertaken within the limits of the present paper. Altho we do not know precisely what is meant by innate

"mental ability," [7] we can nevertheless agree with the conclusions that a given invention "depends upon a certain cultural preparation [of society], and could not be made without the existence of the constituent cultural elements that make the invention." But the "status of culture" is hardly more than a convenient phrase to denote the manner in which individuals or sets of individuals act at one time in contrast with another. And since men, unlike the lower animals, are as Count Korzybski has called them, "time-binders" as well as "space-binders," [8] their behavior and achievements at any one time are influenced appreciably by the accomplishments of the men who have gone before them.

This points not only to the fact that increments of contribution and discovery in the industrial and other human arts are successive, but to the probability that they are substantially cumulative. A far larger proportion of the adult population is to-day, for example, possessed of mathematical, scientific, and engineering knowledge, and ability to use it, than three hundred or even thirty years ago. And increasingly, in perhaps some sort of geometric ratio each year or decade, a larger number of persons is actually able to employ formulae and tables, test tubes and apparatus of various kinds, than was the case in the previous year or decade. This is not, of course, to state that the number of capable persons in proportion to population is greater to-day than in, say, Hellenic times; we simply possess greater powers in certain directions. Because of using them in those directions we may be, and doubtless are, somewhat less able to do other things — say, to write plays

7. Ogburn and Thomas nowhere define the term except to say, "We are here considering native or inherited ability, not the ability that results from training" (p. 87).

8. See A. Korzybski, The Manhood of Humanity.

— than were the Greeks. In any event, the abilities discussed seem in each generation to be acquired ones, not connate aptitudes.

Our increasingly great ability to invent is in part the result of the work of laboratory scientists, in part of "practical" men. Just what the relative importance of these two spheres of experiment is cannot easily be determined. While it seems fairly patent that the one supplements and supports the other, the conclusions of different observers vary greatly. With the chief inventions of the industrial revolution in England, contends Hobson, "scientific men, strictly so called . . . have had very little to do. . . . Among the great textile inventors, Cartwright alone was a man leading a life of thought." [9] On the other hand, Kulischer, in criticizing Brentano in this connection, asserts that men of pure science, while not making the inventions themselves, had a great deal to do with their development. The period of the Industrial Revolution, was, declares Kulischer, an age of tinkering, of awakening mechanics, a period of both scholarly research and popular application of physical principles. Experimentation was "in the air." The work of Huygens and others previously had resulted in the discovery of the principle of "governed motion" (*Zwangsläufigkeit*) in the harnessing of natural forces — and to all of these influences, the textile and other inventions of the late eighteenth century were due.[1]

In support of Kulischer's position, there is to be found in Weber the statement that the seventeenth century witnessed "a feverish hunt for inventions . . . the

9. Op. cit., p. 80.

1. J. Kulischer, "Die Ursachen des Übergangs von der Handarbeit zur maschinellen Betriebsweise," Schmoller's Jahrbuch, 1906. The criticism of Brentano is of his Über die Ursachen der heutigen social Not.

idea of perpetual motion as a source of energy was only one of many indices of this universal movement." [2] Weber also states that one of the significant results of the development of machine technique is that "through its alliance with science, the production of goods emancipated itself from every restraint of inherited conditions." [3] This is somewhat sweeping; but it is suggestive and in large measure doubtless true. The inventor may not be a laboratory scientist; but like the laboratory worker, he has scant regard for precedent *per se*. And that a system of machine production is indeed a constantly changing system of production will be pointed out below.

It is to be noted, that in our time the work of the discoverer is greatly expedited by the disappearance, in large part, of the ridicule and suspicion which formerly attached to inventors and innovators. When Crompton worked upon his spinning-mule at late hours up in his attic at Hall-in-The-Wood, his neighbors declared that the house must be haunted. "Even when relieved from the alarm of a ghost they yet found they had among them a *conjurer!* for such was the term they applied in contempt to inventors in those days, and indeed for a long time afterwards." [4] Crompton was constantly annoyed by persons attempting to break into his loft, or climbing up to look through his windows. But now it is quite the accepted and accredited thing for inventors such as Edison to put in all hours of the morning working deliberately at their discoveries. We are different persons in these respects from the people of a century ago. This fact explains in large measure the widespread exercise of inventive

2. In the interesting chapter on "The Development of Industrial Organization and Technique," in the Wirtschaftslehre, p. 218.
3. Wirtschaftslehre, p. 263.
4. French, p. 38.

abilities. Our relative readiness to accept the possibilities of a new invention, not to deride or disbelieve, has not only "broadened the market" for the sale of new devices, but has encouraged deliberate research and experimentation.

"The fact that modern civilization," wrote Lester F. Ward in 1892, "employs many thousand times as much art as ancient society employed, and continues to employ more and more, shows that there is no necessary limit to the extent to which inventive genius may benefit mankind. The way to bring this about is to increase the demand, that is, to increase the capacity of society for receiving and appreciating these new benefits. It is not the inventor who needs educating, but the user of his invention, i.e. the general public. . . . What is not understood cannot be properly used, and condemnation and complaint are followed by rejection, whereby demand is lowered." [5]

It may be doubted if this conclusion now holds, at least in anything like the same measure as when Ward wrote. So long as human beings have habits, there will always be present a certain degree of inertia in adopting new methods; but its influence in mechanical matters is becoming less and less. Certainly contrivances which are not understood by the user are made and sold widely. It will be granted that the purpose to which a thing is to be applied must be understood before it will be purchased, but given such understanding, one need know little else about it. Few persons using successfully either the automobile or the radio, for example, comprehend either their construction or the principles which underly their operation.

Not only our readiness to accept, but also our willingness to give, made effective by the present high develop-

5. The Psychic Factors of Civilization, pp. 205, 206.

ment of communication and transportation, are to-day influences which doubtless stimulate the making and improvement of new devices. An interesting thesis laid down by Henry Dircks in 1867 was that "Invention and secrecy go hand in hand." [6] How far that is true to-day is open to question. While the details of a number of mechanical, chemical, and other ways of doing things are kept more or less closely, many other methods and formulae of a type previously not divulged by the individuals or companies enploying them are now freely contributed by industrial engineers and managers, through trade journals and at meetings, to a common fund of business practices from which all may draw. Not only this, but present-day entrepreneurs are usually quite ready to permit competitors to go through their plants. I am told on good authority that the following incident recently took place in Detroit. A party of German business men was to be taken through the factory of a leading automobile company. One of the leaders of the delegation, as it was about to set out, said to an official of the company that he thought it only fair to state that in the party were several automotive engineers. If there were any objection to their going through the plant, the leader added, these men would understand it and would willingly remain in the foyer to await the party's return. "Which gentlemen are the engineers?" the official replied, "Point them out to me, please." Upon this being done, the official sent for a supply of paper pads and pencils, which he handed to the engineers, with the remark that they perhaps would see machinery or equipment of which they might wish to make notes or sketches.

6. Inventors and Inventions, p. 47.

IV

The exact extent to which men's actions are now directed deliberately toward the making of industrial inventions is difficult to determine. But it is safe to say that it is greater than ever before.[7] The Dennison Mfg. Co., for example, spends $96,000 [8] a year for methods, research, and new machine designs (exclusive of the labor and materials cost of the new machines themselves). The American Telephone and Telegraph Company, together with its subsidiary, the Western Electric Company, employs "three thousand persons at an expenditure of some nine million dollars annually in their research and development work." [9] Nor do these concerns, among large firms, appear to be exceptions. "Parke, Davis & Company (wholesale druggists), $500,000; Packard Motor Car Company, $500,000; Detroit Edison Company, $130,000; Schenectady Plant of General Electric Company, more than $1,000,000; these amounts represent the sums invested yearly in scientific research by progressive corporations."[1]

The manner in which such inventions are brought into being varies somewhat with the industry or problem at hand. The new device may come as a result of

7. The deliberate attempt to improve processes and equipment, particularly in the industries producing machinery or complex fabricated products, has, however, doubtless long been present in appreciable measure. The Motor World for August 1904, contained the following advertising notice under the caption "Thoughtful Mechanics": — "Positions are open for thoughtful mechanics who can improve details of Rambler automobiles. Only practical men willing to show their ability before remuneration is determined, are desired. — Thomas B. Jeffery & Co., Kenosha, Wisconsin."

8. Approximately one week's entire payroll. Stated in a letter to the writer.

9. M. Pupin, From Immigrant to Inventor, p. 340.

1. From an advertisement of the Guardian Trust Co. in the Detroit Evening Times, August 19, 1925.

some discovery of "pure research" [2] in the laboratory, or as the result of the definite quest of a method for better performing a particular productive operation, of manufacturing or other nature. The question of motive — why and under what conditions the work of inventing a new machine or device is undertaken — we may for the moment postpone, viewing first the process by which devices are sometimes produced.

One manufacturing concern which the writer recently visited invents five or six important new machines each year. These are not all, it is true, machines which accomplish tasks previously performed only by hand. Some merely replace other machines. When such is the case, the new device may or may not operate upon principles substantially different from those underlying the operation of the machine it supplants. It should, however, be clear that all of these machines "deliberately developed" each year are wholly new units, in that they are not mere improvements made directly upon already existing devices; the annual number of such improvements is several times as great. And many of the machines which this company develops, in that they do enable manual operations to be dispensed with, are entitled to rank as "new" inventions, even tho they may seldom be epoch-making in their effects upon the practice of other establishments or industries.[3]

2. I use this phrase in a relative sense, simply to denote research more or less removed from any specific or immediate practical application. The researcher, however, usually has certain general questions in mind, and he looks for the answers to them. See A. A. Young in this Journal for February 1925, "The Trend of Economics, as seen by some American Economists," p. 160.

3. The question of "newness" in an invention raises problems which we have already suggested and shall not pursue further. For practical purposes in the present discussion we mean simply that a machine is new if it accomplishes a particular task in a distinctly different way from that in which this task has been accomplished previously. The new device, thus defined, may employ a considerable number of elements

Three general methods have been employed by this company in developing its new machines. The first method has consisted in turning over the problem at hand to some individual, either in the employ of the company or not, who was reputed to possess marked inventive ability — a so-called "born inventor" — and having him attempt a solution. The second method has been to present the problem to a machine-tool manufacturing concern, and have its engineers work out both the principle and design of the new device in collaboration with the company's own mechanical staff. The third method has been that of attempting to develop new machinery wholly within the company's own organization, by putting the entire staff of its mechanical division to work upon it.

The last method is the only one which has been markedly successful. The chief reason for the failure of the first two approaches seems to have been either the inability or the unwillingness of the professional inventor or the engineering company's designers to acquaint themselves sufficiently with the needs of the company desiring the new machine, and with the exact conditions under which its use would have to be made practicable. The method of turning over the problem to the company's own mechanical division, on the other hand, has brought to bear upon the making of the invention both an adequate knowledge of these conditions and sufficient supervision and inspection during its construction [4] to ensure success in nine out of ten cases.

The deliberate manner in which these inventions are

already known and utilized in the performance of other tasks. But the net gain in productivity which results may be fully as great as if this were not the case.

4. The castings and other parts are made for the company upon order outside of its plant, but much of the drafting for them is done by the mechanical division, and their construction and setting up accomplished under its direction.

"made" is as follows. The idea that a certain operation or process ought to be accomplished by machine instead of by hand may originate either in the factory itself, or be conceived by a member of the merchandising committee or by some executive in the general office. Its desirability being passed upon by several department heads, a member of the mechanical division (or sometimes the person who made the suggestion, if he is possessed of a mechanical training) is then requested to prepare a rough sketch for the device. This drawing is then passed over the desks of several members of the mechanical division, each a specialist, to receive critical estimates as to the contemplated machine's feasibility of construction, the materials to be employed, the practicability and proper mechanical functioning of the machine after it is made, its probable cost of operation, and its prospective performance in terms of physical units of product. If the proposal survives these several analyses, specifications are decided upon and preliminary drawings made. An estimate is then made of the cost of construction, and after this has been approved, detailed specifications are drawn for each part of the machine. It is then built and placed in the factory's experimental room to be tested under actual production conditions. All necessary adjustments are made here, and these may require as long as from several weeks to six months or more. When they have been accomplished successfully, the machine is regarded as perfected for use and is put into service in the department for which it was designed.

How important in the aggregate have these "deliberate inventions" been in the production of this establishment? Altho no precise quantitative estimate is available, their present significance in terms of cost and output would seem to bulk very large. One illustration

may be cited: a large automatic machine now under construction. This device, when completed, will supplant a total of 11 smaller machines of 7 different types. It will dispense with the labor of 20 operatives. It will occupy 100 square feet of floor space (it measures 5 feet by 20 feet) instead of 380 square feet required by the 11 present machines. In terms of physical performance, it will fabricate in 6 seconds a unit of product which takes 2 minutes in aggregate net "machine-time" to pass through the 7 processes as now undergone on different machines. The net economic saving is of course not nearly so large as these figures would indicate, for they take no account of the capital cost of the machine itself. This is included in the estimate of total expense figures per unit of product; and that estimate contemplates that the new machine will turn out the article for forty per cent of the present expense of production. An interesting incidental advantage of the installation of this machine during the present year is that the saving of floor space effected may postpone the necessity for erecting a new building.

The savings effected by this company through the development of new machinery are thus substantial. They are, moreover, constantly being made; so steadily are new machines devised and constructed that the company has found it possible to develop a system of standard machine parts, whereby often new machines which are merely sub-variants of other models may be built of certain basic parts, the detailed drawings and specifications for which need not again be worked out.

Not in every case, however, are the efforts of this concern successful: occasionally the nature of the materials to be processed by the machine, or else the excessive cost of the completed machines in operation, militates against further mechanization of certain phases of pro-

duction. Instances of the first sort mentioned may be called mechanical failures; of the second, commercial. An example of the first is the case of a machine with which experimentation has been carried on for over five years. The operation essayed is that of rounding a small, flat fibre disk. The machine rounds the disk, but too frequently cracks the fibrous composition of which it is made. All efforts to overcome this vital difficulty have so far ended in failure.[5]

An instance of the second sort of failure — inadequate commercial effectiveness — is that of a machine that was developed to perform automatically a certain stamping operation. Mechanically it stamped perfectly; but its output was only 1000 units for every 43½ minutes. The hand-operated machine designed at the plant required the attendance of one operative, but turned out 1000 units in 7 minutes less time. It proved that to run the hand machine even with the employment of the operative, was cheaper than to utilize the newly developed automatic; and after several months of vain endeavor to adjust and speed up the latter, it was ordered dismantled. Its design and construction cost approximately $5000. The company estimates that the average yearly cost of devices which do not prove successful enough to warrant adoption amounts to about 12 per cent of the total research and mechanical construction costs per year. But it none the less often obtains valuable ideas from even these.

Another company, itself a machine-making concern, goes about "making" new inventions in much the same orderly, deliberate fashion. This concern makes primarily machines to execute the picking, carding, and spinning processes in woolen manufacture. The new

5. With this article in proof, I am just informed that the machine has finally been perfected.

designs developed come about as a result of the co-operation of the several members of the productive group engaged in making and using the company's product. Usually the superintendent of the mill to which the company has sold a machine will make some suggestion to the travelling representative of the company. This may be a constructive idea, or may be no more than a complaint as to the way in which the machine is running. In either case, it may emanate from a workman or have been observed by the superintendent himself. It may consist of a request for increased speed, for better quality of work, for freedom from repair or break down, or for a means of handling a new kind or weight of raw material or yarn.

The company's representative notes the remark and analyzes the situation as far as seems necessary. At the factory the matter of a new design of machine or of part is then taken up. The idea of the suggested contrivance is turned over to the head draftsman; he and his helpers draw out the parts; the master molder is summoned and questioned as to the practicability of actually achieving in metal the device depicted in the drawings, and its making is then attempted. Sometimes as many as 20 trials may be made before the successful machine is constructed. There is in this company's procedure, says the manager in charge, no room for an heroic theory of inventions, nor much of sudden inspiration connected with their making — only slow, hard work, careful economic and engineering consideration, and "orderly evolutionary progress." The new ideas or principles executed are brought to fruition through the deliberate and reasoned coöperation of the several members of the organization, no one of whom regards himself as an inventor, but all of whom, taken collec-

tively, may be regarded as an "inventive group." [6] Without the coöperation of any one of them, the invention would not be developed — while behind all of them stand the owners of the company, whose capital enables the 20 or more trials that may be necessary to take place.

Concerted effort of this character may relate in the main, more to the invention of devices which represent either improvements upon existing machinery, or else new applications and combinations of already known mechanical and other principles. It may well be that much of the discovery of "radically new" devices proceeds — perforce must proceed — along somewhat more spontaneous lines. Yet it is difficult to distinguish between these two sets of discoveries.[7] Few new mechanical devices are now developed which do not draw very markedly upon principles embraced, in one manner or another, by existing contrivances; while in the field of pure scientific research made prior to the application of principles, certain corporations now engage deliberately and extensively.

V

Another theory of invention remains to be examined: that which seeks to explain the invention in terms of pecuniary motive. This approach does not stress the

6. This phrase is suggested to me by Miss Gibson, through whose courtesy I was made acquainted with the experience of the company above discussed. A much broader connotation can of course be given to the idea of an inventive group by conceiving of the whole complicated occupational division of labor in society, and its part in the making of new devices. See Herbert Spencer, The Study of Sociology, pp. 126–128, where an account is given of the evolution of an automatic printing machine, the Walter-Press. Cf. also A. P. Usher, Industrial History of England, pp. 251, 252.

7. Except perhaps in terms of their effect upon production, as suggested in a previous note.

technical necessity, or even desirability, of the development of particular devices, but sees in the opportunity for commercial profit the whole *raison d'être* of the exercise of inventive abilities. Men are mere pawns in the service of capitalists; inventions are the inevitable concomitants of a régime of economic competition.

To such explanations we may apply the term "materialistic." They are related in several ways to the theories already considered, but differ from them in their rigid insistence upon the thesis that, without the spur of competition among capitalists, improvements in technology would not take place. Changes in the industrial arts constantly occur, and in this view they follow the law of commercial gain. The utility or nonutility of inventions to the community at large, in this view, is not in itself an effective regulator of the application of inventive energies; not utilitarian desirability, but commercial opportunity and competitive necessity, are the operative forces behind all innovation.

The most striking advocate of this doctrine is Marx. To him, machines are only incidentally contrivances for saving labor; primarily they are devices to increase the surplus value of the product. Marx quotes Mill's statement to the effect that "it is questionable if all the mechanical inventions yet made have lightened the days' toil of any human being," and adds: "Mill should have said, 'Of any human being not fed by other people's labor,'" [8] for the net result of inventions is to augment the profits of the employer.

Our present interest lies not in Marx's conclusions as to the effect of inventions upon the distribution of wealth, but in the process by which he explained their continual contrivance. Modern industry, with its huge power-driven factories and its vast body of me-

8. Capital, vol. i, p. 405 (Moore and Aveling translation).

chanical apparatus, came about because handicraft and small-scale home production "no longer sufficed for the extending market and the still more rapidly extending competition of the capitalists." [9] Now that the machine industry is here, it "never looks upon and treats the existing form of a process as final." Competition continues; and so "the technical basis of industry is therefore revolutionary, while all earlier modes of production were essentially conservative." [1]

This, too, is the view of Veblen: that continual invention and discovery are the inevitable concomitants of a régime of economic competition and large-scale mechanical production. "The complex of technological ways and means grows by increments that come into the scheme by way of improvements, innovations, expedients designed to facilitate, abridge or enhance the work to be done. Any such innovation that fits workably into the technological scheme, and that in any appreciable degree accelerates the pace of that scheme at any point will presently make its way into general and imperative use, regardless of whether its net ulterior effect is an increase or a diminution of material comfort or industrial efficiency . . . particularly if the new expedient lends itself to the service of competitive gain. . . ." [2]

A materialistic view of slightly different character is that recently expressed by Dr. Reginald A. Fessenden, himself an inventor of some note in the field of radio appliances.[3] "No organization engaged in any specific field of work," states Dr. Fessenden in his autobio-

9. Vol. i, p. 516.
1. Ibid.
2. The Instinct of Workmanship, p. 314.
3. Dr. Fessenden's inventions include what is said to be the "first wireless telephone," the submarine telephone, the Heterodyne principle used in all Super-Heterodyne receivers, and "over 300 other important inventions." — Radio News, January 1925, p. 1140.

graphy,[4] "ever invents any important development in that field, or adopts any important development in that field, until forced to do so by outside competition." In support of this "law of invention," as he styles it, Dr. Fessenden cites fourteen examples of discoveries which either were not made by, or have been declined by, the companies which are now using them. He concludes that "an inventor of an important method for making tea or storing power should *not* take his invention to those engaged in selling tea or generating power, because there is less prospect of their adopting it than substantially any other class or organization."

To this view there are obvious objections. One of Dr. Fessenden's examples to prove his law is that "the gas companies did not invent the electric light." True; but that is merely to state that the invention of devices embodying a wholly new basic principle may not be made by the persons engaged in working with devices that are already in use. The more significant question to ask would be whether or not improvements made in *gas* lighting came from persons connected with or working for light companies. With respect to a lack of readiness on the part of companies to accept new inventions suited to the production or sale of the kind of commodities they are engaged in supplying, it may be admitted that there resides in most human beings a certain inertia which opposes any quick adoption of new ways of doing things; and business managers are no exception to this rule. But let the new method carry on its face a reasonable promise — not to mention a guaranty — to perform the task for which it is intended in a substantially more effective manner than the old, and it is not long before it is adopted. The inventor

4. The Inventions of Reginald A. Fessenden, the first installment of which appears in Radio News, for January, 1925. All citations here given are from this first issue.

may of course fail to convince a particular business man of the effectiveness of his invention. The company which first refuses to adopt the device may possibly be forced to do so later by the competition of a second company which does install it. But to say that the inventor ought not to take his device to concerns within the industry for which it is designed because no firm will accept it willingly, seems to misstate and not merely to overstate the case.

There is an additional reason, beyond that of the adherence to traditional ways of doing things, which accounts for the rejection of new devices by many firms when they are first offered. This is the fact that, unless the saving which the new machine promises to make is so great as completely to offset the capital loss which may be entailed on old equipment, it does not pay to abandon the old. The new method may be the cheaper, itself considered; but it is often not the cheaper for either the individual firm or for society to adopt at the moment of its invention. Such has been the case with the motor truck, the electric locomotive and recently developed units. Until the units already installed are worn out, a universal change to the new may not be advantageous. And in those instances where the standardization or the alignment of processes requires complete uniformity in the units of equipment (as in, for example, a telephone company), no installation at all of new units may be possible for a considerable time.

Given these qualifications, it seems by no means true that the severest and keenest competition is the one thing that induces a company to develop or to adopt an invention. Nevertheless, the question remains: is Marx correct in placing such great emphasis upon the profit motive as the cause of the development of new devices?

It cannot be denied that in periods of depression, when competition to sell is keenest, the necessity of paring down expenses is a powerful stimulant to the devising of cheaper methods of production. It would be interesting to know how many inventions, or the ideas out of which they develop, are born in times of bad business. One obvious counterbalancing influence to the incentive to devise or adopt new inventions at such times is lack of funds with which to finance experiment or purchase. To enterprises whose credit remains unimpaired, this difficulty does not apply; but these are ordinarily the firms least "forced" by competition to adopt new devices.

Even companies which maintain their own research staffs, and constantly do bring forth inventions even tho not forced to do so by any competition immediately present, frankly admit that such a policy serves to anticipate competition at a later date. "The best way to meet competition" says an executive of one such firm, "is to keep ahead of it." The new machinery which this company develops in its plant often enables it either to gain an increased profit on certain items for a considerable period of time, or to extend its market for certain products by lowering prices if demand is elastic. When some other company does just this latter thing, however, then it must actually "meet" competition or lose orders. One newly designed machine now running in this company's plant is the result of the sales department having reported a year and a half ago that it lost a large order because it had quoted a price of 67 cents per dozen articles, as against a competing company's quotation of 55 cents.

The successful working of this particular kind of calculation of course presupposes an adequate system of cost accounting. Such a system probably is not pos-

sessed by more than three or four out of every ten firms which manufacture a variety of product under a single roof, where the manufacturing operations are not clearly segregated.[5] Yet where the management is intelligent, and statistics pertaining to marketing as well as production are carefully compiled and studied, it seems clear that competition serves as a powerful stimulus to the development of new devices; and the extent to which their development is currently being thus accomplished is perhaps far larger than commonly supposed.

We come now to a final question: would the continued development of new devices take place were it *not* for the profit motive? The answer depends upon two things: whether individual inventors (as distinct from engineers or mechanicians employed by manufacturing establishments) do contrive and invent, independently of the allurement of substantial monetary rewards; if so, whether the contributions which they have made form any substantial part of the total volume of new devices which have steadily streamed forth since the industrial revolution.

There is probably no specific instinct of workmanship, invention, or contrivance.[6] But there do clearly seem

5. Such is the estimate of M. G. Gerard, an industrial engineer of wide experience, in a privately printed pamphlet entitled Costs — and their Fallacies (New York: Gerard, Graham and Company, 1918). My own less extensive observations lead me to believe that this figure probably does not at all overstate the actual situation. That a number of concerns have carried cost keeping too far, needlessly elaborating it and sometimes even making their cost systems too complicated for effective use, does not alter the fact that too few establishments keep costs sufficient for proper control purposes.

6. See J. R. Kantor, "A Functional View of Human Instincts," Psychological Review, January, 1920; also C. E. Ayres, "The Instinct of Belief in Instincts," Journal of Philosophy, October, 1919; also J. B. Watson, Psychology from the Standpoint of a Behaviorist.

to exist in all of us certain general capacities which may be developed in such a manner that we do come habitually to contrive, analyze, and tinker. In some persons these habits are developed to such an extent that it appears they can do little work of any other sort and remain satisfied. Such have been — to mention a few outstanding individuals — Cartwright, Fulton, Watt, Oliver Evans, Eli Whitney, John Ericsson. Cartwright especially was remarkable in this respect; he "made bread in his own kitchen by machinery; published a scheme for rendering houses fire-proof; invented bricks on a geometrical system; helped Fulton with his first steamship models; brought chemistry to bear upon the science of agriculture; introduced a new three-furrow plow; . . . and obtained patents for calendaring linen, making ropes, and cutting velvet pile. Indeed it may be said of him that he went to the grave inventing." [7] Similarly, R. E. Olds, whom we have mentioned as one of the inventors and early builders of automobiles in this country, worked upon his "horseless carriage" for 14 years before producing a model which would satisfy the necessary canons of simplicity in construction and ease of operation and repair. This inventor has stated, in connection with that protracted period of experiment, that he "could n't help it," and that "16 or 18 hours of work a day, which for long stretches at a time I did, mean nothing if one's heart is in the work." [8]

It would seem from instances such as these that society could get at least some of its inventions gratis, or for very small sums. But here arises the second of

7. Burnley, History of Wool and Wool-combing, p. 132. Quoted in Taussig, Inventors and Money-Makers, pp. 26, 27.

8. In conversation with the writer, September, 1925, at Lansing, Michigan.

the questions suggested: what proportion of the really usable inventions comes from inventors who invent simply for the sake of inventing?

As regards past periods (the 18th and 19th centuries), there has been insufficient study. But for the first quarter of the present century, there may be hazarded the guess that by no means the major portion of new and improved appliances is devised by such persons. The professional inventor, in the verdict of industrial managers, is often a "crank," is "impractical," "unresponsive to suggestion," "hard to control." The greater number of usable offerings (in several industries at least) appear to come from machine-tool makers, mechanical specialty manufacturers, practising engineers, or the employees, or members of the supervisory forces, of plants and factories. A large American railroad, for example, some few years ago announced an open competition for the development of a safety device. A total of 4500 designs was submitted. Only seven were sufficiently practical to merit serious consideration. All of these seven were from engineering companies, and the two designs to which the choice finally narrowed down were submitted by companies that specialized in the manufacture of safety devices of that general character. "These two are backed by the two largest . . . companies in the country, who have spent millions in the development of their devices." [9]

Other companies, in other industries, have attempted to deal successfully with individual inventors, but often to little avail. Either these individuals lack sufficient financial resources, or else do not apply them in a sufficiently practical manner. "These men are 'smart,' but have no sense." They go "crazy" on the subject

9. From the letter of an official of this railroad.

of "just puttering around," making "fly-swatters" or "door-closers" or what not.[1] And their abilities, in consequence, are made use of but infrequently.

There are, of course, exceptions. Edison, in spite of the fact that much of his time has been spent in contriving devices for which there has existed no genuine demand (such as the vote-counting machine for Congress) or in industrially impractical projects (such as the scheme to extract iron ores magnetically from the deposits in New Jersey), has made a vast number of useful inventions of the highest importance for industry. The late Charles P. Steinmetz, who voluntarily drew from the General Electric Company only a small salary to meet the needs of a plain living, made tremendous contributions in the field of electrical discovery. He worked upon most of these, it seems clear, chiefly for the sake of contriving and contributing. But the question which remains is: how large a proportion of society's mechanical, electrical, and other devices comes from men like Steinmetz?

VI

To know how much weight may be attached to any one, or any parts of, the several theories above reviewed, a careful counting of actual facts is required. A series of comparable inventions — or several series of such inventions — ought to be drawn up, and analyses made of the historical, biographical and scientific facts surrounding each discovery or contrivance. In this way

1. Anyone who thumbs through a number of the Patent Gazette (issued monthly by the U. S. Patent Office to list and describe the new patents granted) can see this at a glance. Almost everything, from hydraulic baby carriages to pocket umbrellas, offers itself. "Frederick P. Fish, the 'dean' of the patent bar, expressed the belief that four out of every five inventions that are patented are for worse ways of doing something that is well done already." — Vaughan, op. cit., p. 208, citing Nolan Hearings of 1919, p. 63.

something like classification and frequency distributions, correlations and preponderant trends (or their absence) might be attained. The list of Ogburn and Thomas already cited, gives a chronological series of discoveries, but a heterogeneous one. What is needed for the purpose here indicated is one list, for a particular industry, fairly homogeneous in the items. For each list of devices, of this character, there could be drawn up — from historical, biographical and scientific characteristics which could be enumerated — parallel lists of the conditions surrounding each invention or discovery, and an actual tabulation of the frequency of occurrences might then be made.

The following is suggested as an illustration of a tentative working program for research upon one such list of homogeneous inventions. It could be supplemented by a number of similar lists for other fields of industry; and comparison of the findings could then be made to detect similarities or differences as between the fields of industry themselves. The master list is given first, the parallel lists follow:

1. Important mechanical inventions in textile manufacturing from 1589 [2] to 1920, with names and dates of the principal inventors (whether one or more in each case).

(*a*) Inventors of these devices, together with the main occupation, pursuit or trade of each, both prior to and at the general time of the discovery.

(*b*) Pure scientific discoveries preceding or closely paralleling these same inventions and related to them.

(*c*) Length of time required to bring to commercially successful application the mechanical or other principles involved in the idea of each invention.

2. The approximate date of Wm. Lee's invention of the stocking-frame; the exact year in which this important invention was made is somewhat in doubt.

(*d*) Approximate amount of earnings received by either the inventor or the "inventive group" for each invention.

(*e*) Number of patents taken out on each invention.[3]

(*f*) State of trade activity at the time when research was initiated or experimentation most vigorously prosecuted.

To obtain these data would be difficult at best, and in some cases impossible. But to the extent that historical and current industrial research will furnish them, some systematic array of facts is indispensable to the formulation of any sound and comprehensive theory of invention. Unqualified theorems we may never be able to lay down; but some conclusions might perhaps be obtained as to the direction which methods of production may take in the future. Perhaps it would appear that the ability and the readiness of men to contrive and construct new devices is not nearly so flexible as some have of late supposed. Or it may be that, given the possibility of a sufficiently large supply of capital, we have only to press buttons to witness the installation of new mechanical, chemical, and electrical ways of doing things *ad infinitum*. Should the former situation be the one actually prevailing, then substantial betterment in the material conditions of man-

3. Some firms which now maintain large research laboratories or "deliberately invent" new machinery, do not patent their inventions at all. The reason is, in many cases, that to enforce a patent entails litigation that is too long and costly to be profitably undertaken. Other inventors, notably chemists and physicists, working in the laboratories of universities, have not patented their discoveries either, but for another reason: they have wished them to be free from profit to anyone, themselves included. A tabulation showing the percentage of instances in which inventions of a given general type are patented might thus disclose either the absence of a money motive on the part of the inventor, or the presence of a defective patent system; but such information might be of value despite the fact that it would not, of itself, be conclusive as to motive.

kind, as population grows, can in the main come about only through the conservation and better utilization of resources, a more intelligent ordering and apportionment of the present productive energies, and changed schemes of consumption. But should the latter situation prevail, we may look to positive increases in production as one of the chief sources of further advance in material welfare. In this event the mechanization of industry may take place on a scale heretofore uncontemplated; the external economies of the future may be far less important than the internal economies; and the industrial revolution may proceed indefinitely.

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THE DEVELOPMENT AND PURPOSES OF FARM-COST INVESTIGATION IN THE UNITED STATES

SUMMARY

I. Four methods of collecting cost data: route method, survey method, questionnaire, farmer's record, 274. — History of the movement, 275. — II. Influences promoting the movement, 277. — Efficiency, country life, tariff inquiries, cost in relation to price, 278. — III. Price-fixing as an object, 283. — Farm efficiency, 284. — IV. Difficulties in the way of accuracy, 286. — How deal with managerial ability, rent and land value, joint costs, 287. — Cost records of doubtful value; problems of averaging, 287. — Not easy to advise farmers what to produce, 291. — Conclusion, 293.

THE statistical investigation of farm costs of production [1] has become an important type of economic research in the United States during the past twenty-five years. At present the federal Bureau of Agricultural Economics, the United States Tariff Commission, and more than half of the state agricultural experiment stations are systematically engaged in farm-cost inquiry. A considerable sum of public money has been devoted to such investigation annually during the past few years; and funds available through the recent Purnell Act will presumably increase the amount. If we add that expansion of cost inquiry is undoubtedly contemplated by leaders of agricultural thought at the present

1. By a farm-cost investigation is here meant any statistical inquiry which presents real or money costs incurred on a group of ordinary farms in the process of producing specific farm products or of conducting specific farm operations. Cost statistics from single farms or from experimental inquiries are not regarded as farm-cost investigations. Statistical inquiries involving the collection of farm financial records are regarded as cost inquiries only when costs are allocated to specific products or specific operations, like wheat or milk, plowing or harvesting.

time, the importance of this type of economic research is evident.

It is the purpose of the present paper to outline broadly, for readers not particularly familiar with research in the economics of agriculture, the significant aspects of investigation into farm costs of production. It will deal with the growth of cost inquiry, the causes of this growth, the general objectives and the present status of cost investigation, and the significant limitations on such research. None of these aspects of farm-cost inquiry, however, more especially its present status and its limitations, can here be dealt with exhaustively or in detail.

I

The general development of agricultural cost investigation in the United States can best be traced by reference to the different methods which have been employed in the collection of cost data. Broadly speaking, four methods [2] are in use at the present time. The *route method* involves direct supervision of from 15 to 50 farmers by a special paid agent. He submits complete farm-cost records at frequent intervals to the agricultural experiment station, where these are posted to ledgers, and summarized and utilized in various ways. Sometimes the costs of but a single enterprise (for example, pork or wheat) are obtained by the route method; in this event more farms are included on the route. The *survey method* involves the personal visiting of several hundred farmers by an agent who obtains, on prepared forms,

2. These four methods are classified somewhat differently by F. W. Peck, Methods of Conducting Cost of Production and Farm Organization Studies, U. S. Dept. Agr. Bulletin 994, November 1921. Mr. Peck combines the route method and the farmer's record method into the "accounting method," and includes the questionnaire method under the survey method. I adopt a different classification chiefly for the purpose of clarifying the history of cost investigation.

once for all, each farmer's estimates of items of cost for selected enterprises or operations, and usually obtains also estimates or actual records of the farmer's complete farm business. The *questionnaire method* resembles the survey method, but utilizes the mails rather than special field agents for reaching the farmer. The *farmer's record plan* involves summary and analysis of more or less complete cost records kept by competent farmers, with occasional assistance from the investigating agencies.

Systematic attempts to determine farm costs of production under actual farming conditions began in 1902, when Professor Hays of the University of Minnesota, in coöperation with the Division of Statistics in the United States Department of Agriculture, inaugurated the route method. Before this time some interest had been shown in farm costs: cost data of an elementary type often accompanied reports upon feeding or fertilizer experiments, notes on new crops, or news items dealing with farm prosperity. There were, also, a few sporadic cost investigations, of more elaborate character, most common during the eighteen-nineties, and in general intended to throw light upon the "vexed question" of agricultural depression. On the whole, these were of little importance.

After 1902 the systematic study of farm costs grew. The questionnaire method has been the least used: it was momentarily revived by the federal Bureau of Statistics in 1910, and since 1923 it has constituted part of the routine work of the Bureau of Agricultural Economics; but it has seldom been employed elsewhere. The route method, continuously employed in Minnesota except in 1918 and 1919, became suddenly popular after the war. In 1920 six cost routes were operated by state agricultural experiment stations,

usually in coöperation with the federal Bureau of Agricultural Economics; in 1924 the number had risen to fourteen.[3] Before the war the survey and farmer's record methods held the field. The former, originated by Dr. Warren at Cornell University in 1903 (in a form dealing with farm incomes and profits rather than with costs of production) was adopted gradually by other agricultural experiment stations, and also by the United States Tariff Board in its examination of the woolen industry in 1910. After 1912 this method began to displace the farmer's record plan in the federal Office of Farm Management, where the latter method had been inaugurated by Dr. Spillman in 1906. At present only two agricultural experiment stations cling to the farmer's record plan, whereas the survey method is employed by many stations, by the Bureau of Agricultural Economics, and by the Tariff Commission. The route and survey methods are now regarded with about equal favor, the one for intensive investigations, the other for extensive; they are in fact thought of as complementary.

In 1902 no organizations except the Division of Statistics in the federal Department of Agriculture and the Division of Agriculture in the University of Minnesota were directly and systematically concerned with farm-cost inquiry. The federal Office of Farm Management, organized in that year, was then conceived merely as an agency for translating the accumulated scientific knowledge of the Department of Agriculture into farm

3. This rapid increase was primarily due to war-time price-fixing experiences. Congress requested the Department of Agriculture in 1918 to ascertain the cost of wheat production. The inquiry, conducted by the survey method, was severely criticized, and eventually a committee of experts was called upon to reorganize the Department's work in agricultural economics. The committee emphasized the accuracy of the route method, and the influence of its conclusions and recommendations has been apparent. But the survey method, properly executed, is still favorably regarded for its speed and cheapness; and its accuracy can be successfully defended.

practice, and it was an unimportant appendage to the Bureau of Plant Industry. Farm management and agricultural economics were subjects taught in only a few scattered agricultural colleges, and cost investigation as a field for research in these subjects was scarcely thought of.

At present, farm management and agricultural economics are recognized subjects in practically all of the agricultural colleges, and cost investigation is regarded as a field for research in most of the agricultural experiment stations. Twenty-eight experiment stations were engaged in cost inquiry in 1923. The federal Office of Farm Management is now merged, together with the former Bureau of Markets and Bureau of Statistics, into the influential Bureau of Agricultural Economics. Cost inquiry (largely in coöperation with the state experiment stations) holds coördinate rank with the investigation of marketing and with the crop-estimating service of the reorganized bureau. A flourishing American Farm Economics Association exists, and many of its members are concerned with cost inquiry. Farm-cost investigation has become an important duty of the United States Tariff Commission. If $10.000 of public money was spent on farm-cost inquiry in 1902, $500,000 is a conservative estimate of what was so spent in 1924. The increase in systematic farm-cost investigation has been at least fifty-fold in the past twenty-five years.

II

The influences mainly responsible for this remarkable increase are complex and interrelated. We may, however, list five causes more or less distinct: the general extension of economic studies; the efficiency movement; the country life movement; the "scientific tariff" movement; and cost-and-price disputes. All

of these developments have exerted direct or indirect influence on farm-cost investigation.

The general growth of interest in economics during the past twenty-five years is familiar. An important aspect of this growth has been the application of statistical method to economic research. The growth of interest in economics involved the extension of statistical inquiry to every aspect of economics; and farm cost of production was one of outstanding importance.

What has been called the "efficiency movement" took root first in industry, particularly manufacturing, largely under the leadership of Frederick W. Taylor in the eighteen-nineties. In the first decade of the present century leaders in agricultural education began to plead for better business methods, better management, more efficiency, on the farm. References to the necessity for regarding farming as a business, and for applying business methods to farming, became common in the agricultural press. Cost accounting was an accepted method of increasing efficiency in business; and the same method came to be regarded by leaders in agriculture as necessary for farming. This type of reasoning was specifically expressed by Professor Willet M. Hays, the originator of the route method of farm-cost investigation, in the first important document dealing with statistics of farm costs of production:

> System and efficient management are undoubtedly greater factors in the success of American manufacturies and railroads than natural advantages. . . . The success and prosperity of the American farmer are due to the unbound fertility of the soils, the cheapness of farm lands, and the privilege of utilizing modern inventions in machinery rather than to systematic organization and efficient management. . . . System and more efficient management must enter the realm of agriculture if reasonable profits are to be extracted from the soil and its fertility be conserved for the use of future generations.[4]

4. The Cost of Producing Farm Products, U. S. Dept. of Agr., Bur. of Statistics, Bulletin No. 48, 1906, pp. 9, 10.

The first in time of the two most widely employed methods of investigating farm costs, the route method, was thus originated as a part of the efficiency movement as applied to agriculture. This movement has grown in strength. Efficiency on the farm may to-day be accepted as the slogan, expressed or unexpressed, of all leaders of agricultural thought. In 1900 the idea was new.

The country life movement, made much of during President Roosevelt's second administration, had its roots in general alarm at the movement of rural population towards the cities in the early years of the present century. In 1908 President Roosevelt, seizing upon a growing interest in rural problems, appointed a Country Life Commission to investigate all aspects of rural life in the United States and to make recommendations for the betterment of rural living. Two of the commission's three recommendations, expressed in its Report in 1909, had an important bearing on the increase of cost investigation. The first recommendation called for a systematic investigation of rural conditions by agricultural surveys; the second called for extensive development of the extension form of agricultural education, "reaching the people at home and on their farms."

Agricultural surveys, as we have seen, had originated as early as 1903. The commission's report brought such work into prominence, and gave an impetus to its expansion. Educational organizations developed an increasing interest in rural economics; existing departments of farm management and rural economics were enlarged; new ones were formed; all were interested in the agricultural survey. The notion naturally arose of using the survey method to investigate farm costs of production. Extension work in agricultural education

had been developing even before the investigation of the Country Life Commission. In 1902 the Office of Farm Management, intended as an extension agency, had been founded in the Bureau of Plant Industry of the federal Department of Agriculture. In 1903 the coordination of educational work already being pursued by farmers' institutes was undertaken by Congress in a small appropriation for a federal farmers' institute specialist. In the same year farm demonstration work was begun in the South for the purpose of teaching farmers a system of farming capable of minimizing the ravages of the boll weevil. Demonstration work increased in popularity in succeeding years, and was adopted by the Office of Farm Management. In 1914 the recommendation of the Country Life Commission was finally made effective by the passage of the Smith-Lever Act, which provided for county agricultural agents as well as for machinery to supervise their activities in bringing agricultural science to the farmer. These county agents and their superiors often found themselves at a loss to know what sort of teaching was needed to improve farm conditions in their localities, and employed the survey as a method of finding out. Thus the use of the survey method, which dealt principally with questions of farm prosperity — income, expenditures, receipts, and their causes — but could be employed also to ascertain costs of production, was given a tremendous impetus. The country life movement thus contributed to an increase in farm-cost investigations at least in two ways: by focussing attention directly upon the survey method of research, and by expanding extension work which found the survey method useful.

We need not inquire into the origin and development of the idea that the tariff should be based on differences

in costs of production at home and abroad. One phase of agricultural costs of production, the costs of wool, was investigated in 1910, by the newly formed Tariff Board. The Tariff Commission, succeeding the Board in 1916, investigated the costs of producing sugar in 1917. More recently the costs of producing wheat, butter, and sugar-beets have been investigated; for the "flexible provisions" of the Tariff Act of 1922 have made the Commission's most burdensome duty the investigation of costs of production. The agricultural depression of 1921–24 raised the question of tariffs on agricultural products far more seriously than was true before. As a consequence, farm costs of production have been increasingly in the public eye.

The final influence has been the prevalence of cost-and-price disputes. These disputes, during the eighteen-nineties, gave rise to most of the elaborate cost inquiries conducted before 1900. In the early years of the present century cost-and-price disputes were few; prices seemed satisfactory to most farmers for most commodities, with the possible exception of beef and the certain exception of milk. Constant agitation for clean milk and increasingly severe sanitary requirements by local governmental agencies had been forcing farmers to purchase better dairying equipment and to pursue more careful methods; and in time farmers began to complain that the cost of production of clean milk was higher than the price which consumers were willing to pay. This attitude brought forth official cost investigations in many localities; the fact seemed to require tangible proof; and resulting cost figures were supposed to quiet the complaints either of consumers when prices were raised, or of producers when prices were not raised. Milk cost investigations were of frequent occurrence from 1910 to 1920; but with the advent of the United States into

the war in 1917 and subsequent debate about price-fixing, the costs of other agricultural products also began to attract attention.

Since 1900 it has been thought by many that costs of production must be used as the basis for price-fixing if prices are to be fixed at all, the popular argument being that the farmer must have a price sufficiently high to guarantee him a "fair" profit, but not so high as to make him a profiteer. From 1917 to 1920 cost investigations were common; investigators saw in cost figures a possible if not a certain basis for price-fixing, and also an argument to demonstrate that farmers were not getting too much. After 1920, when prices went down, costs were still regarded as useful to show that farmers were getting too little.

III

The broad purpose of farm-cost investigation, as a type of economic inquiry conducted by agencies responsible primarily to farmers, has always been to discover means whereby the economic welfare of farmers can be advanced. If, it has been argued, the profits of every farmer can be increased, then the economic status of the farming class will be improved. It is apparent, however, that a great many factors affect farm profits — prices of farm products, yields, freight rates, marketing methods, efficiency in farm operation, and the like. Inquiry into farm costs of production with the purpose of increasing farm profits has been directed at only two of the factors — prices of farm products, and efficiency in farm operation. Farm-cost investigators have thus had two major objectives in mind, the control of farm prices and the increase of farm efficiency. Each of these requires some further analysis.

The control of prices of farm products by the use of

farm-cost statistics has been approached from various directions. Cost data have been regarded as a suitable basis for price-setting by coöperative producers' associations, for tariff-making, or for legislative or administrative price-fixing. They have also been regarded as effective propaganda in inducing consumers to pay higher prices by demonstrating that farmers were not receiving "reasonable" profits. With respect to the increase of farm efficiency, cost statistics have been thought to be useful in the solution of several important aspects of the farmer's production problem. Cost data have seemed particularly capable of solving the problem of output (what to produce and in what proportions) and the problem of operation (which methods and practices pay best, or which combinations of the cost-factors pay best, or what intensity of cultivation pays best). They have likewise seemed serviceable in the solution of the investment problem (how much, what proportion, and what equipment in the form of land, buildings, livestock, machinery, and labor is desirable) and of the problem of disposition (whether to feed or sell, and when and how to sell).

Farm-cost investigation has thus been regarded by its sponsors as a tool useful to serve at least eight different purposes, most of them of rather wide significance. On the whole, however, its history is a history of disappointed purposes. Experience in cost inquiry has served to cut down the list of objectives considerably. Few leaders of agricultural thought now entertain the notion that cost statistics serve effectively as propaganda to induce consumers to pay higher prices, or, as this use is more euphemistically expressed, to "place the producer and the consumer on a better basis of mutual understanding." [5] Fewer still suppose that

5. F. W. Peck, op. cit., p. 5.

cost statistics really provide a sound basis for legislative price-fixing, tho this idea is still current among the rank and file of farmers.[6] To some extent price-fixing on the cost-plus basis has been displaced by the "ratio price" idea embodied in the McNary-Haugen Bill. The notion of using farm-cost data in tariff-making is on the decline, if the President's recent comment upon the Tariff Commission's investigation of sugar costs can be regarded as evidence. The only price-regulating purpose of cost inquiry still regarded favorably is that of determining what prices producers' associations shall ask; and to leaders of agriculture this is scarcely an important purpose.

Agricultural leaders are, however, still enthusiastic in regarding cost investigation as valuable in the slow process of increasing farm efficiency. At the present time a considerable expansion of cost inquiry designed to serve this end is contemplated. Agricultural leaders in 31 states have recently expressed themselves in favor of the formulation, by governmental agencies, of programmes involving the collection, analysis, and dissemination of data on supplies, movements, prices, demand, and costs of farm products, to the end that farmers may be taught efficiency in production. The Bureau of Agricultural Economics likewise strongly favors this activity; and the Secretary of Agriculture has expressed himself as an advocate of "putting more 'business' into farming."[7]

6. "One part of the program formulated at the meeting of farm organizations in Des Moines on May 12 provided for the 'creation of an export corporation, by Congress, to be managed by a board of farmers nominated by the recognized farm organisations and to insure the farmer cost of production plus a profit of not less than five per cent.'" Price Current Grain Reporter, June 10, 1925, vol. xcii, p. 821.

7. Cf. J. D. Black, The Rôle of Public Agencies in the Internal Readjustments of the Farm, Jour. Farm Econ., April 1925, vol. vii, pp. 153–175; also secretary of Agriculture Jardine's speech delivered at Mandan, N. D., July 4, 1925.

Of the recognized divisions of the farmer's production problem, only two, the problems of output and of operation, are at present receiving considerable attention. Obviously, little can be done with the problem of investment, because even tho changes in investment seem desirable, farmers are often not able to rectify past mistakes and frequently are not in a financial position to make suggested outlays. Little can likewise be done with the problem of disposition when the determining factor is the price of alternative products, and those prices cannot be known with precision in advance, as the farmer must know them when planning his business.

At the present time, then, the important recognized objectives of farm-cost inquiry are to teach farmers what to produce and in what proportions, and how to combine the cost factors in the detailed processes of production.[8] Other objectives, certainly among agricultural leaders and to some extent among the rank and file, have largely come to be regarded as unimportant or impossible of achievement or undesirable in themselves; they have been either abandoned or neglected, or are in the course of abandonment. But it is for the purpose of increasing farm efficiency that cost inquiry may be expected to expand. Leaders of agriculture have faith in it for this purpose, and increased funds for

8. These objectives owe their present popularity largely to the belief of many influential farm economists that promising new methods of cost analysis have been discovered in the past three years, and that these methods, combined with price and yield forecasts now being developed, will yield results much more satisfactory than has been possible heretofore. Lack of space prevents a detailed explanation of these new methods; but interested readers may find them in the following publications: G. A. Pond and J. W. Tapp, A Study of Farm Organization in Southwestern Minnesota, Minn. Agr. Exp. Sta. Bulletin No. 205, November 1923; H. R. Tolley, J. D. Black, and M. J. B. Ezekiel, Input as Related to Output in Farm Organization and Cost-of-Production Studies, U. S. Dept. Agr. Bulletin No. 1277, September 1924. The latter proposes the application of the intricate method of multiple curvilinear correlation to cost data.

the state agricultural experiment stations have recently become available through the Purnell Act. If agriculture prospers through remunerative prices in the next few years, the expansion of cost inquiry may be only slight. If prices fall, we may expect renewed proposals for measures to relieve the farmer; and cost inquiry is certain to be one of these. It may take the form of propaganda, or it may again be revived as a basis for price-fixing. In any event considerable effort will be devoted to cost inquiries designed to increase farm efficiency.

IV

The essential characteristics of farm costs of production are that costs are extremely difficult to obtain with even a fair degree of accuracy; that once obtained, the costs of a given product or operation vary widely among different farms in the same year; and that costs vary widely on the same farms in different years. These characteristics — far less widely recognized fifteen years ago than they are to-day, and perhaps not too clearly recognized even now — combine to render the investigator's task extremely difficult, whatever the objective he wishes to achieve.

By way of illustrating these difficulties, we may consider broadly certain problems which the investigator faces in employing cost data for two purposes: to calculate a duty on wheat, and to determine what products, in what proportions, the farmer should produce. These objectives are typical of the two major classes of objectives in farm-cost inquiry, the price-controlling and the efficiency-increasing. It is not within the scope of this paper to discuss the general theoretical aspects of basing a tariff upon differences in costs of production between different countries. We are concerned only with the technical procedure necessary in calculating a duty.

What is required in the calculation of a tariff rate on wheat[9] is a figure showing the difference in cost of production per bushel in the United States and in the competing country. But this figure is not so easily reached as is commonly supposed. First of all, there is a problem of accounting principle and of general economic reasoning: what elements shall be included in cost? In addition to the usual charges for labor and materials, shall a charge be made for the farmer's managerial ability, for interest on growing crops, for transportation from farms to a central market,[1] and for rent of land? In practice it is not feasible to reckon interest on the growing crop or managerial ability, tho both may properly be regarded as elements of cost. No equitable basis of calculation is available; neither item has a calculable market value. If rent be included in cost, and the resultant tariff raises domestic prices, it may be reasoned that land rents must rise also, in turn increasing costs of production and periodically necessitating fresh calculations of tariff duties, each duty higher than the preceding. From the public's point of view, an outcome of this kind is obviously questionable. But if rent be excluded from a calculation made while land values are inflated, a decline in land values, detrimental to recent purchasers and contrary to the expectations of farm owners, is conceivable. And will the exclusion of rent from costs serve to protect the interests of tenants? What to include in cost is thus an intricate problem in tariff-making, and equally in price-fixing.

A further difficulty, again one of accounting principle, is the valuation of non-cash cost items. Rent of

9. We need not discuss complications due to the fact that types of wheat differ in different countries.

1. This item, actually of considerable importance in tariff-making, as is the problem of selecting a "central market," need not concern us here. It is an element in total cost, but not in farm cost.

land is one of these to farmers who own their farms. Shall rentals be calculated on the basis of land value multiplied by a specific interest rate (and if so, at 4 per cent or 8 per cent or somewhere between) or on a cash rental basis; and how shall share rentals be handled? Under the one method, too high a cost item can be calculated if the rate is too high or if the land value is too high. Depreciation of livestock and machinery is another of these non-cash items difficult to evaluate; the labor of the proprietor and his family is a third; home-grown seed is a fourth; horse labor is a fifth; manure is a sixth. Interest on growing crops and managerial ability might also be listed, if it were customary to reckon these items. The number would be increased if an animal product were under investigation; for in this event home-grown feeds must be evaluated. Non-cash costs make up over 50 per cent of total costs on most farms. To adopt high valuations may result in costs per unit unbelievably high—an important matter in legislative price-fixing, and not unimportant in tariff-making.

The allocation of joint and overhead farm costs to specific products constitutes another problem. This is difficult whenever more than one product is produced on farms, sometimes even then. Artificial fertilizer, barnyard manure, and green manure all affect the crop of more than one year; and how to determine what part of a given charge for manure ought to be charged to each succeeding crop is uncertain. Overhead costs like fencing and road-repair are difficult to allocate. Most difficult of all is a proper allocation of costs for joint products like veal, beef, butter, and milk; or mutton and wool. The costs of livestock products are particularly susceptible to inaccuracy on account of problems of allocation.

Even if these problems could be satisfactorily solved, the tariff-maker or price-fixer must encounter still further difficulties. How many cost records must be obtained in order to achieve a fair statistical sample, if costs vary widely from farm to farm in the same year? If costs vary widely on the same farms from year to year, how many years shall be taken? The yield of wheat varies so widely, and is so important in its effect upon costs per bushel, that at least a five-year period seems theoretically necessary for long-time price-fixing or tariff-making; and the value of money may change in the meantime. But if even a ten-year average is taken as the basis, costs in the eleventh year may be either far above or far below the average ten-year cost; and in this event either consumers or producers will be dissatisfied with the eleventh-year fixed price or tariff.

Further, what method shall be followed in collecting data? Few farmers keep cost records. To keep records for farmers on a large scale is expensive: it costs at least $2,000 a year merely to gather records for a single enterprise from 50 farms by the route method. In order to obtain many estimates, the mail questionnaire must be simplified so far that its value is doubtful; and it can easily be tampered with. The survey method seems most suitable in a price-controlling cost investigation; but it rests upon estimates dependent on the farmer's memory, which is perhaps not wholly trustworthy when he knows that his costs are to be employed in price-fixing. This bias can doubtless be largely overcome by the skill of the agent in asking questions and checking answers one against the other; but it is likely to remain to some degree.

Problems of averaging — for some sort of an average is requisite in tariff-making — are also raised by the wide variation of costs from farm to farm in the same

year. Cost data from many farms do not cluster closely about a particular figure. Shall the simple or the weighted average be used, or must recourse be had to some other device like the median, the mode, or the bulk line? The bulk-line method alone ordinarily yields an "average" cost figure higher than the costs of 85 or 90 per cent of the individual producers; but an average resulting from the bulk-line method is open to objection as arbitrary and unscientific. Other methods ordinarily yield — the variation in individual costs being what it is — an average cost figure higher than the costs of from 65 to 75 per cent of the individual producers. But such a figure, in price-fixing for example, would leave from 25 to 35 per cent of the individual producers still to produce at a loss. Are we to say that a fixed price or a tariff rate is intended to guarantee a "fair" profit (whatever a "fair" profit may be) only to 65 or 75 per cent of the producers? Some producers are presumably inefficient, and deserve neither guaranteed profits nor full tariff protection. But what proportion is in fact inefficient — 5 per cent or 35 per cent — cannot be ascertained accurately, because no criterion of efficiency has as yet been developed. It is at present not possible, at least with any pretense of scientific accuracy, to establish a particular average cost figure and argue that all who produce at higher costs are inefficient.

These difficulties, primarily due to the fundamental characteristics of farm-cost data, combine to render cost inquiry far from an adequate and acceptable basis for price-control of any sort. The most impartial investigating agency is liable to serious inaccuracies of one sort or another. Most of all, it faces a quite insoluble problem in employing past costs to control future prices. A biassed agency, confronted by the same difficulties, is in a position to adjust its figures to meet pre-

conceived conclusions, often without the possibility of detection. To put it plainly, cost data are essentially untrustworthy for price-control. Their inherent characteristics render them unsuitable for the purpose, and they are peculiarly subject to manipulation. These facts are for the most part recognized at the present time; but many laymen still look to cost investigation as a basis for legislative price-fixing and for tariff-making.

A different matter is that of the difficulties faced by the investigator who proposes on the basis of cost investigation to inform the farmer what to produce and in what proportions. He may seek to advise farmers in only a restricted area,[2] and may thus obtain accurate data by the route method or by a combination of methods. He may avoid problems of valuation to a certain extent by concentrating on costs in terms of hours of labor, quantities of material, and the like rather than in terms of money; and this procedure has in fact become increasingly common among farm management specialists.[3] In the end, however, the more enthusiastic advocates of cost inquiry wish to teach large numbers of farmers what to produce *next year*, and net profit remains their criterion. A farmer must ordinarily plan

2. It is probable that in townships where cost accounting routes have been conducted for some years, the general level of economic intelligence among coöperating farmers and perhaps throughout the locality has been raised; and doubtless some improvements in farm organization and operation have been made in such localities. (Cf. G. A. Pond, The Use of Detailed Cost Studies in Improving Farm Organization in a Community, Jour. Farm Econ., January 1924, vol. vi, pp. 69–81.) The probability remains, however, that many of these observed improvements could have been indicated and put into effect without the aid of expensive and elaborate cost data. The actual contributions of cost inquiry to farm efficiency, even in some of the localities where it has been longest conducted, are surprisingly meagre.

3. Some costs, however, like rent of land and depreciation of equipment, cannot be expressed in other than monetary terms, and thus constitute a problem not to be avoided by recording real costs only.

his business in the winter, plant in the spring, and harvest and market in the summer and fall. The investigator must therefore be able to determine relative profits on a large number of possible crop combinations several months in advance if he wishes to give the farmer instruction when it can actually be put into effect — sometime before spring planting.

This cannot be done, particularly for large numbers of farmers, with any helpful degree of certainty. Profits depend upon prices of produce and on yield as well as upon costs of production. Last year's profits will not be next year's, if costs, prices, and yields fluctuate on the same farm from year to year, as they admittedly do. It is quite impossible to calculate accurately what combination of crops will be most profitable next year unless it is also possible to forecast what next year's yields and next year's prices will be for each of the products grown. Similarly, the most profitable combination of cost-factors for producing a specific product or operation cannot accurately be calculated in advance, so long as future prices and yields cannot be determined.

It is, of course, mistaken to assume that economists and agricultural specialists can do nothing whatever with the problem of price and yield forecasting, and we make no such assumption here. But it is equally mistaken for advocates of farm-cost inquiry to underestimate the difficulties of forecasting, or to assume that next year's prices and yields can be foretold even within 10 per cent of accuracy. Yet a useful calculation of future net profits necessitates a close fore-knowledge of changes in both direction and degree of next year's prices and yields of many farm products. Relatively small errors in forecasting the *degree* of next year's price and yield changes may be well-nigh as important in a calculation of future net profits as errors in forecasting

the *direction;* and as yet we cannot look forward to more than a possibility of forecasting the direction of next year's changes.

If advocates of farm-cost inquiry gave proper emphasis to the fact that forecasting is requisite in teaching farmers what to produce and how to produce, and if the difficulties of forecasting to reach the specific figures necessary in a calculation of future net profits were more generally acknowledged, it is doubtful if the two most favored objectives in cost inquiry would long retain their present popularity. The newly devised methods of farm-cost analysis do not solve these problems; nor do the sponsors of the new methods appear to give proper weight to the distance which forecasting has still to traverse.[4] It is questionable whether the new methods of analysis justify any extensive increase in the expenditure of public funds for cost inquiry. The ultimate fact is that cost data, however carefully collected and analyzed, as yet serve only to explain last year's profits, not to determine next year's; and often they do not explain last year's particularly well.

One necessarily concludes that the practical value of farm-cost inquiry is still considerably overestimated. Sufficiently accurate data are exceedingly difficult to obtain, partly because of the inherent nature of farm costs, partly because of the expense involved. Cost data do not provide a satisfactory basis for artificial price-control. They are less useful in the process of increasing farm efficiency than is commonly supposed, even by

4. Much might also be said of the expense and difficulty of analyzing last year's cost records rapidly enough to bring conclusions home to the farmer in time for him to employ them in planning next year's operations. The procedure of analysis is in itself exceedingly difficult, and the new device of multiple curvilinear correlation analysis renders it more so than before. The extension problem of bringing home conclusions to farmers in anything like an adequate manner is an exceedingly large one.

those most familiar with cost investigation and even under the new methods of cost analysis.

For more modest purposes than those commonly formulated, cost data are none the less valuable. They certainly provide a fund of information not otherwise accessible on past changes in the conditions of agricultural production. They seem capable in time of throwing some light upon the theory of cost-and-price relations. They may be made to provide useful information to farmers in the form of standards of efficiency for conducting specific operations, when expressed in terms of real rather than of money costs; and they are not without value when employed in restricted localities. What degree of precise utility they can reach, remains to be ascertained. It will be found in the future, however, to be considerably less than has been assumed by the advocate of farm-cost inquiry in the past.

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PROGRESS AND POVERTY IN CURRENT LITERATURE ON VALUATION

SUMMARY

The publications reviewed: Bauer, Lyndon, Maltbie, Nash, Raymond. — I. Retrospective and prospective regulation as affecting the basis of valuation, 297. — II. Valuation as a means of controlling profits and as a means of controlling charges, 302. — III. The market value fallacy in the determination of "fair value," 307. — IV. Consistency in the development of a valuation theory, 314. — V. Conclusions, 325.

PROGRESS in a social science is not always marked by an increasing tendency of experts to agree on problems of public policy. A far more trustworthy sign of progress is the tendency of scientists to realign the issues, to analyze their problems in new ways, and to base their conclusions, however divergent, on considerations different from those which were adduced by their predecessors. Present-day economists differ widely in their position, let us say, on the protective tariff. But no reputable economist would now resort either to the arguments which the mercantilists brought forward in support of protection, or to the crude over-generalizations with which the Manchester school rationalized its desire for free trade.

In comparison with the older phases of economics such as the tariff, the study of public utility valuation is still in its infancy. As an elaborate and organized field of research it hardly antedates the publication of Whitten's able treatise, the first volume of which appeared in 1912.[1] Yet such a vast amount of time and thought

1. R. H. Whitten, Valuation of Public Service Corporations. N. Y., vol. I, 1912; vol. II, 1914.

have been devoted to the subject during these intervening years that one may fairly expect to find in the most recent literature the same marks of progress that have characterized the scientific discussions of the more time-worn economic problems.

With the object of discovering to what extent this fair expectation has been realized the present article will discuss in turn several aspects of the problem of valuation as developed in five of the latest volumes in the field of public utility regulation. No attempt will be made by the reviewer to offer correct solutions to the problems which these writers discuss. The inquiry will be confined to the methods by which the various authors analyze their problem and to the consistency with which they apply their general principles of valuation to the different items of the appraisal. One highly important phase of valuation, the subject of depreciation, will be omitted from discussion in this review. The problem there involved is so complex that it demands more space than can be assigned it here, and it is therefore reserved for separate discussion in a later issue of this journal.

Of the five books selected for review [2] three are writ-

2. John Bauer, Effective Regulation of Public Utilities. New York, The Macmillan Co., 1925. 381 pp.

Lamar Lyndon, Rate-Making for Public Utilities. 1st ed. New York, McGraw-Hill Book Co., 1923. 209 pp.

W. H. Maltbie, Theory and Practice of Public Utility Valuation. 1st ed. New York, McGraw-Hill Book Co., 1924. 201 pp.

L. R. Nash, The Economics of Public Utilities — A Reference Book for Executives, Investors, Engineers, and Students. 1st ed. New York, McGraw-Hill Book Co., 1925. 430 pp.

William C. Raymond, The Public and Its Utilities. New York, John Wiley & Sons, 1925. 346 pp.

I have omitted from this list two of the more recent publications on public utility control because, while they contain much interesting material, they do not develop a theory of valuation at such length as to warrant detailed criticism. M. L. Cooke, ed., Public Utility Regulation, N.Y., Ronald Press, 1924. H. C. Spurr, Guiding Principles of Public Service Regulation, Public Utility Reports, Inc., Rochester,

ten by members of the engineering profession (those by Lyndon, Nash, and Raymond), one by an attorney (W. H. Maltbie) and one by an economist who has been recently associated with the Corporation Counsel of New York City as an adviser on public utility problems (Bauer). Mr. Nash is associated with the well-known public utility engineering house of Stone and Webster, while Mr. Maltbie has been an attorney for various public utility enterprises. As might be expected, the books of these last two writers bear obvious earmarks of special pleading, and it may therefore hardly seem fair to apply to their arguments the same tests of scientific rigor and self-consistency to which the works of impartial students are necessarily subjected. Any misgivings in that direction, however, are overcome by the fact that both of these authors present their discussions, not as briefs for the defense, but rather as contributions to the enlightenment of the public.

I

Retrospective and Prospective Regulation as Affecting the Basis of Valuation

Writers on public utility control have generally attacked the problem of valuation from one of two quite distinct points of approach. To some the problem has presented itself in the form and with the emotional coloring of the question, "What is fair?" [3] Here it is assumed that public utility rates, and consequently

N. Y., 1924. Cooke's book is a series of articles by different authorities on various aspects of public regulation. Spurr's two large volumes (vol. I, 1924; vol. II, 1925) are a compilation with commentaries of judicial and commission opinions on valuation and the fair return. As reference books they should prove very useful.

3. This, indeed, is the precise title of an earlier book on the subject by Mr. Raymond, author of one of the volumes under present review. What is Fair? N. Y., John Wiley & Sons, 1918.

public utility valuations, should be set at the lowest points consistent with justice to those who have contributed capital to the enterprises.[4] By these writers the choice between replacement cost and actual cost, or between cost new and cost depreciated, is made to rest primarily on arguments as to the *right* of utility investors to share with other property owners in land-value increments, and as to the *obligation* of these same investors to undergo losses through depreciation and obsolescence similar to those incurred by the holders of industrial securities.

To other writers, however, the choice of a basis of valuation seems to rest, primarily at least, on an appeal to considerations, not of "fairness," but of "expediency" in the narrow sense of that term. These writers support this basis or that, not on the ground that its acceptance provides the only honorable and decent settlement of the claims of security holders, but rather that its adoption is necessary in order to attract capital, or to stabilize rates, or to do other things which are conceived to be in the interest of the consuming public.

That both of these criteria of sound public policy must be taken into account in the solution of the valuation problem would be granted by nearly everyone. Nor is it to be inferred from what has just been said that writers in the field have treated the problem from one point of view to the utter exclusion of the other. What they have generally done, however, is to allow the one aspect to dominate their whole discussion and to treat the other only as an incidental and disturbing element

4. Some of those who look upon the problem from the "fairness" angle would doubtless object to this statement of their position. They would insist that the problem is to find a rate base which is at once "fair" to the investors and "fair" to the consumers. I have not been able to discover, however, that this double-barrelled concept of fairness connotes anything materially different from the principle stated in the sentence above.

in the total situation. They have failed, moreover, to make a clear-cut distinction between considerations of "fairness" and considerations of "expediency." As a rule they have been all too ready to assume, either wholly without argument or else with the most superficial type of apologetics, that whatever rate base they happen to like because they think it is *fair* to existing investors is also the best because it will attract the most capital from future investors; or, conversely, that whatever basis they approve because they think it will attract capital is also one which conforms best to the requirements of justice to security holders. The general impression which one gets from these discussions is much the same as that which the photographic novice receives when he discovers, to his dismay, that he has taken two pictures on the same negative. One of the pictures is almost sure to be dominant, but its outlines are blurred and distorted by the subdued presence of the other exposure.

If students of public utility valuation had only dissected their problem and had considered first the fairness question alone and second the expediency question alone, they would have clarified the issue and would probably have come much closer to a satisfactory resolution of the difficulty. For they would then have seen that the question of fairness to investors is germane only to a very special and restricted phase of the problem of valuation — namely, to the problem of retrospective valuation. It arises in rate cases simply because in America we have put the cart before the horse; we have encouraged private investors to contribute capital to public utility enterprises without telling them definitely on what basis their rate of compensation is to be computed. By this reversal of the normal order of contractual arrangements we have allowed the whole problem

of the basis of valuation to be dominated by considerations of "fairness" based on the "reasonable expectation of investors" — considerations that do not arise when the terms of compensation are precisely stated before investors have committed their capital to the enterprise. Of course it is now too late to avoid the difficulty of an *ex post facto* settlement. The question of a *fair* adjustment of the claims of existing investors must necessarily be faced in any reasonable solution of the valuation problem. But this undoubted fact does not justify the treatment of this one phase of the problem as if it were the whole problem. It requires, instead, that the two questions of retrospective and prospective valuation be kept quite distinct instead of being jumbled together in a futile attempt to hit two birds with one stone.

Fortunately the necessity of making this distinction has for some time been apparent to some of the keenest writers in the field of public utility regulation. To John Bauer, more than to any other one writer, belongs the credit for bringing this necessity to the attention of his associates. In various articles appearing in the technical journals Bauer has constantly stressed the vital need of settling definitely the claims of present investors in order to clear the way for an effective control of rates in the future.[5] This object he would attain by means of a final and fixed valuation of existing property, a valuation to be based largely on actual cost but to be modified where the use of actual cost would not meet the reasonable expectation of present investors. With this fixed valuation as a starting-point, he would thereafter allow additions to the rate base only to the extent of additional investments by the security holders.

5. See, for example, Pol. Science Quarterly, vol. 30, pp. 106–133, 254–276 (1915); ibid., vol. 31, pp. 260–288, 413–429 (1916); Am. Econ. Rev., vol. 8, March Supplement, pp. 113–140 (1918); ibid. vol. 15, pp. 586–591 (1925).

Bauer's recent volume is simply an elaboration of this proposal. Space is unfortunately lacking to discuss either the feasibility of a final valuation of existing property or the fairness of the basis on which the valuation is arrived at. Those are matters on which opinions may legitimately differ. But on one point there seems to me no room for disagreement: it is that Bauer has definitely shown the necessity of treating separately the valuation of existing property and the valuation of future property. Any future treatise which disregards this distinction will be an anachronism.

It remains to note to what extent the above-noted distinction has been observed in the other four volumes under review. Maltbie observes it at the outset of his discussion (pp. 5, 6), where he remarks that a public service commission faces a much simpler problem in fixing the rate base for a new public utility than in setting the base for a property that has been hitherto unregulated. But despite this auspicious beginning, Maltbie proceeds to disregard the vital distinction which he has himself suggested and to jumble together, in the familiar manner of our judicial decisions, arguments which rest now on an appeal to notions of equity and now on an appeal to notions of public expediency. This mode of reasoning is hopelessly confusing to the scientific student, altho it may be very helpful when viewed from the standpoint of its usefulness in defending whatever combination of "elements" of valuation will result in the highest rate base for the public service companies. At a later point in this review more will be said of its helpfulness in this respect.

Of the other three writers under review — Nash, Raymond and Lyndon — no one analyzes his problem into its two components of retrospective and prospective regulation. Nash, to be sure, seems more inclined to

defend his valuation principles on grounds of the public necessity of attracting capital, while the other two are more disposed to emphasize considerations of fairness. All three, however, fail to keep distinct these two sides of their problem. As a consequence none of them considers whether a different rule of valuation should be applied to already existing property and to future property. It may be, of course, that no different rule is called for and that a single criterion of "fair value" should be accepted. But such a conclusion, if it is justified, can be intelligently reached only after careful consideration of alternatives.

II

Valuation as a Means of Controlling Profits and as a Means of Controlling Charges

In most discussions of valuation the problem of limiting public utility profits to a "fair" return on the investment, and the problem of fixing the rates which these same utilities may charge for their services, are assumed to be simply the same problem stated in different language. Those rates are thought to be "fair" which are sufficient, but no more than sufficient, to yield a "reasonable" return over and above expenses. It has long been recognized, however, first by students of railway transportation and later by students of local public utilities, that the criterion of fair return on the investment is not in and of itself sufficient to determine the *relative* rates that must be charged for the many different types of service which these companies perform. In consequence writers in the field of rate control have usually divided their subject into two parts, the one part dealing with the general rate level, where the test of "fair return" is applied, and the other part deal-

ing with the individual rates, where various other tests of reasonableness have been applied. This distinction is now so generally accepted by reputable students that it need not be amplified in the present review.

In making the above distinction, however, writers have been prone to draw from it an unwarranted inference. They have generally assumed that, when once the question of *rate differentials* is settled, the further question of the *rate level* can be disposed of by reference solely to the test of reasonable return to security holders. They have thus identified the question of the fair level of charges with the question of the fair rate of return on the investment. This general assumption, that a proper level of rates is a level which will yield no more and no less than the proper rate of profits, cannot be allowed to pass unchallenged. In certain cases, at least, the assumption can be shown to be invalid. One example is that of a public utility furnishing service the potential supply of which is seriously limited — let us say a company furnishing natural gas. It may be a grave mistake, in such a case, to require the company to reduce its rates of charge to a point which will yield no more than a "fair return" on the investment. For with charges so low, the demand for service may greatly exceed the supply, and many gas users who would be willing and able to pay a much higher price for the service will not be able to satisfy their demand. The best solution of this difficulty may therefore be to raise prices to a point where demand and supply are substantially equal but to prevent by means of an excess-profits tax [6] the accrual of excessive profits to private investors.

6. In practice, however, the usual way in which this problem has been met is by rationing the limited supply rather than by lifting the rates. Economists, however, will recognize that the device of rationing has serious defects.

Cases of the natural-gas type, however, have been of too limited importance to catch the imagination of current writers in the field of public utility control. If considered at all, these cases have been thought of as freaks, to which the general rule of rate making does not apply. They have not been allowed to overthrow the well-established assumption that, in the normal situation, public utility charges should be just high enough to yield a fair profit to investors.

More recently, however, a new turn has been taken in the field of railway regulation which, because of its nation-wide importance and its widespread publicity, bids fair to give the *coup de grâce* to this complacent preconception. The framers of the Transportation Act of 1920, facing the impossibility of fixing rates that will at the same time be adequate to support the credit of the weaker roads and yet not excessive in their yield to the stronger roads, has attempted to cut the Gordian knot by means of the famous recapture clause. In passing this portion of the Act, Congress has thus gone definitely on record as recognizing that the goals of fair return for each individual company and of fair rates of charge are not necessarily identical and that they can sometimes be reached only by two jumps instead of by one.[7]

It must be admitted, of course, that the special circumstances — the presence of directly competing railway lines — which led Congress to drive a wedge between the regulation of charges and the regulation of profits does not prevail to any similar extent with the

7. Congress, however, still adheres to the position that a proper rate level is that which will result in a "fair" return on the various railway *groups*. Moreover, it apparently intends that the consolidation of railways will ultimately make it possible for each individual company to earn no more and no less than a "fair" return without resort to the recapture clause.

local public utilities. But the mere fact that the wedge has been driven suggests the necessity of reviewing the whole theory of public utility rate control with the distinction between reasonable rates and reasonable profits in mind. It is not unlikely that such a review would lead to the conclusion that the basis of rate control should be entirely distinct from the basis of profit control, and that any discrepancy between the income from the rates and the desired return on the investment should be balanced, on the one hand by an excess-profits tax, on the other hand by a governmental subsidy. Actual cost, for example, because of its stability and its consequent effectiveness in attracting capital, might be chosen as the basis on which to compute the return; while reproduction cost, or possibly some index number designed to rise and fall with the general level of commodity prices, might conceivably be chosen as the proper basis by which to regulate charges.[8]

8. The objections to the use of the simple device of price fixing as a means of preventing the accrual of excess profits to quasi-monopolistic enterprises will be recognized by economists if they bear it in mind that the problem of economic rent is involved. Suppose, for example, that public utility charges were so limited as to yield no more than a "fair" return on the actual cost of the property, despite the fact that land values have increased and that the general level of construction costs has greatly risen. It is by no means certain that the relatively low rates for service which the utility would be compelled to charge would not redound primarily to the benefit of real-estate owners rather than to the benefit of non-real-estate-owning consumers. How much, for example, of the benefit of the present low (five-cent) subway fare in New York accrues to the tenants of the up-town apartment houses who ride back and forth at the low rate, and how much of it is taken away from these tenants by landlords who can charge higher rents for proximity to the cheap rides? Possibilities like this should give pause to those representatives of the public interest who advocate a simple actual-cost basis of rate control as a means of giving to the community at large rather than to favored individuals the benefit of the unearned increment. This and other objections to the use of actual cost as a basis of rate control have been discussed at length by H. G. Brown, who approaches the subject from the viewpoint of a single-taxer. ("Railroad Valuation and Rate Regulation," Journ. Polit. Econ., vol. 33, pp. 505–530, 1925.) See also his Transportation Rates and Their Regulation (N. Y., 1916).

But even if we assume that political or other practical considerations preclude the separation of the rate base from the profit base, it is none the less necessary to distinguish these two functions of valuation for purposes of analysis. Only by so doing can we arrive at an intelligent choice of that base which is the best adapted to play the dual rôle which must be assigned to it. Yet most writers have not only failed to make this distinction in their analysis but have apparently failed to see that the rôle now being played by valuation is in fact a dual one.[9]

For a correction of this serious shortcoming in our valuation literature we look hopefully to the five latest volumes in the field. All of these books were written some time after the passage of the Transportation Act, with its clear-cut distinction between price control and profit control. Yet we are doomed to disappointment, for only one of the authors, Bauer, brings the distinction over into the field of the local utilities and even he does not develop it at length. Bauer does, however, recognize the problem, and he suggests that it may be wise to fix public utility rates for commercial customers on the basis of "what the traffic will bear," any resulting excess earnings to be used either to secure a reduction of residential rates [1] or else to increase the public revenues (pp. 290, 291). This same possibility has been

9. For a clear recognition of the distinction, see, however, an article by R. L. Hale, "Economic Theory and the Statesman," published in The Trend of Economics (R. G. Tugwell, ed.), N. Y., 1924.

1. In his treatment of public utility rates, Bauer shows a desire to reduce rates for the ultimate consumer (for example, the residential customer) but to maintain them at the maximum for the commercial customer. The commercial customer, Bauer thinks, would not be likely to shift the major part of any rate reduction to his own customers in the form of lower commodity prices. I wonder, however, whether there is not an equal likelihood that residential customers may have to give up the benefits of low utility rates to their landlords in the form of higher rents.

considered by Bauer at some length in an earlier discussion of railway rates.[2] His failure to discuss its full implication in his present study of local utilities is due, I infer, to a feeling that the question of the return to investors should first be settled before the refinements of the rate structure can be profitably treated. In this opinion he may be right, altho I have some doubt whether the problem of the reasonable return can be effectively settled until we know more than we now know about the related problem of the reasonable rates of charge.

III

The Market Value Fallacy in the Determination of a "Fair Value"

The starting point of nearly all discussions of rate-making valuation is the famous dictum of the Supreme Court in Smyth v. Ames[3] to the effect that a public utility is entitled, under ordinary circumstances, to earn a "fair return upon the value of that which it employs for the public convenience."

This rule, constantly reiterated by courts and commissions in rate cases, would seem to imply that the only problem in the determination of a rate base is to discover what is the "real value" of the property which is being devoted to public use. But a difficulty arises here. For if "value" is used in the sense of *market value*, or of *value to the owners*, it would be fallacious to use it as a criterion by which to test the fairness of the earnings. The value of a public utility to its owners is almost entirely dependent on its earning power, which is the

2. "Federal valuation of railroads in relation to a definite policy of national railway control." Amer. Econ. Rev., vol. 8, March Supplement, pp. 113–140 (1918).

3. 169 U.S. 466, 547 (1898).

very thing to be regulated in the case at bar. The market value of the utility depends largely on what investors think its earning power will be. And it would be obviously absurd to use this market estimate of what the earnings *will* be as a measure of what the earnings *should* be.

The clear impasse to which the use of market value or earning power as a test of reasonable earnings would lead has now been recognized by all but a few die-hards among the utility advocates. And one might fairly infer that the Supreme Court meant something other than market value when it insisted on the constitutional right of a utility to earn a fair return on the fair value of its property. The reasonableness of this inference, indeed, derives support from the fact that the Court in its later decisions has at times refused to accept capitalized earning power as a test of "fair value." [4] It derives further support from the fact that the Court has repeatedly refused to overrule rate reductions which seemed at least likely to lower the company's earning power. Nevertheless it has been pointed out by two of the ablest critics of judicial valuation [5] that in their written opinions at least (whatever may be said of the actual decisions) various Supreme Court justices have by no means cleared their analysis of the earning-power fallacy. For while they have occasionally repudiated it when they have recognized it in its undisguised form, they have frequently allowed it to slip into their apologetics under the mask of such general and ambigu-

4. Note, for example, the refusal of Mr. Justice Hughes in the Minnesota Rate Cases, to calculate the "fair value" of the property by a process which, he thought, involved "an appreciation of the returns from rates (when rates themselves are in dispute)," 230 U. S. 352, 455 (1913). Cf. R. L. Hale, Valuation and Rate-Making (N. Y., 1918) p. 22.

5. Hale, op. cit., chap. 1; Gerard C. Henderson, "Railway Valuation and the Courts," Harvard Law Rev., vol. 33, pp. 902–928, 1031–1057 (1920).

ous concepts as "going-value" or "value of intangibles." The fact, for example, that a certain gas plant has established connections with customers has been said to entitle it to a valuation of something more than the "bare bones" of the physical property, because it "is self-evident" that "there is an element of value in an assembled and established plant, doing business and earning money, over one not thus advanced."[6] A moment's reflection will expose the presence of the market-value fallacy in this assigned reason for allowing the extra amount. For it is obvious that a gas plant with connections will not be *worth* more (to the owners) than the cost of the "bare bones" of the plant unless the rate-making authorities see fit to let it *become* worth more by the allowance on an extra item in the rate base.

It should be noted here, however, that in most cases, possibly in every case, where the courts have justified their actual decisions by resort to the fallacious market-value reasoning, they might have based these very same decisions on other grounds which, whether sound or unsound, at least avoid any obvious logical fallacies. For example, the allowance of an added amount for the "established business" of the gas plant might well have been defended on the ground, not that the connected plant is *worth* more than the cost of its bare bones, but rather that an established plant should be allowed something to offset the actual or presumptive lean years through which a new public utility must go before it can earn normal profits. The allowance would thus be based not on a recognition of *values*, but on a recognition of necessary *costs*, and would avoid the objection of circular reasoning.

It is therefore an open question whether the market-

6. Des Moines Gas Co. v. Des. Moines, 238 U. S. 153, 165 (1915).

value fallacy which undoubtedly persists in many of the opinions of higher and lower courts is not sheer and meaningless dictum,[7] without any material influence on the rulings as to the constitutionality of the particular rates under litigation. However one may answer this question, one nevertheless cannot doubt that the persistence of the fallacy has at least been a serious obstacle to a scientific treatment of the principles of valuation. And one therefore turns from the confused apologetics of the courts to the presumably more sophisticated analysis of the experts in the hope of finding complete escape from the incubus of the market-value fallacy.

In Bauer's book this hope, I think, is realized. Bauer's training has been that of an economist, and he therefore follows the general practice among modern economists of confining the use of the term "value" to market value. Accordingly his support of any particular basis or element of so-called valuation is never premised on the assumption that the proper measure of the rate base is the *value* of the property. To Bauer the correct test is cost as distinct from value.

Raymond, no less than Bauer, begins his discussion with a clear distinction between market value and so-called value for rate-making (chap. 21). Under proper regulation, to be sure, he thinks that these two items will tend to approximate each other, but that is

7. The force of this sentence, however, is challenged by a recent decision of a lower federal court as to the final valuation by the Interstate Commerce Commission of the Los Angeles and Salt Lake Railroad Co. (N. Y. Times, December 9, 1925). According to newspaper accounts, this decision holds the Interstate Commerce Commission in error in valuing a railroad for rate-making purposes at a different figure from the value that would be fixed for taxation or for purchase and sale. "True, actual value," the court is reported to have said, "is the proper test in all these cases." If the Supreme Court of the United States should uphold such a view, on appeal, it would make a laughing-stock of the whole scheme of rate control by valuation.

because market values will conform to the rate base rather than the reverse (pp. 250, 251). This excellent beginning might be expected to guarantee that Raymond in his subsequent analysis would steer clear of the market-value pitfall to which he has himself called attention. But on one occasion, at least, the author seems to have fallen into the trap. For in an extended discussion of going-value he suggests a method of computing it which takes as the basis of computation an assumed earning power (pp. 256 ff.). This is a clear example of circular reasoning, since it takes for granted the very earning power which is subject to determination.[8]

Lyndon, like Raymond, recognizes the distinction between a rate base and a commercial valuation (pp. 64 ff.) and in general observes the distinction throughout his discussion. At one point, however, he seems to me to confuse the issues — in his treatment of depreciation. Depreciation, he thinks, should be deducted since it represents a reduction of the "real value" (p. 26) of the plant. In support of this view he quotes with approval an opinion of the New York Public Service Commission for the Second District, which holds that a certain piece of property, altho its efficiency may be unimpaired, "is clearly not worth so much" as a new unit would be worth and therefore that its value

8. It is surprising how easily some of the most noted members of the engineering profession have fallen into this same fallacy. See, for example, an elaborate method of computing going-value developed by Messrs. Metcalf and Alvord, Transactions Am. Soc. Civil Engineering, vol. 73, p. 326. The propounders of this method proposed it as equally applicable to purchase cases (where a city takes over a private property) and to rate cases. Yet the computation was based on a capitalization of assumed future income, a fact which made the resulting figure pertinent only to the former type of case (the purchase) and not to the latter. This very criticism was made by one of the engineers who discussed the proposed method (Mr. Burns, pp. 356, 357), but its force did not seem to impress itself on the authors, who maintained their original position in a rejoinder.

for rate-making purposes should be depreciated (p. 31). The quoted opinion pretty clearly involves a confusion on the part of the Commission between commercial value and rate base. It may be that no such confusion was in Lyndon's mind, and that he is using the term "worth" and "real value" in some other sense than market value. But these esoteric notions of a value distinct from market value need to be explained in order to be understood by the reader. And one looks in vain for any such explanation in Lyndon's book.

Like the other writers, W. H. Maltbie concedes the distinction between market value and rate-making value. His concession, however, is reluctant and half-hearted. "It must be recognized," he says, "that this test of the market value of securities, when used to determine the value of the public utility for rate-making purposes, involves to some extent reasoning in a circle. It is, therefore, not strictly logical to attempt to determine value as a basis of rate-fixing by the consideration of evidence of value which depends upon existing rates. This lack of logical basis for the application of this particular test of value would be sufficient to prevent its use as a conclusive measure of value, but it does not prevent its use as evidence to be presented and considered by the regulatory body" (p. 28). Evidently, then, a little illogicality is desirable as adding the necessary spice to that mysterious compote of elements called "fair present value."

Nash, no less than the others, takes early note of the objection to the use of market value or earning power as a criterion of fair rates (pp. 114, 115).[9] Indeed, with

9. Nash, however, makes a valiant attempt to absolve the Supreme Court from the charge of circuitous reasoning which is apparently involved in the famous Smyth v. Ames dictum. He points out that while the Court there referred to "earning power" as one of the determinants of the "fair value," it was earning power "under particular rates pre-

the object of guarding against confusion, he uses the now current term "rate base" as an improvement over the ambiguous "fair value." Unfortunately, however, the full implication of this proper distinction is not always observed in the subsequent analysis. Thus, in defending the right of a hydro-electric company to earn a return on at least fifty per cent of the "appraised value" of its riparian rights, the author remarks: "That there is value in such rights cannot be questioned because through them it is possible to furnish electric service to customers within the limits of economic transmission at lower cost than from steam or other alternative power" (p. 134). "That water powers have a value in addition to the cost of their physical construction is indicated by the charges made by the United States for hydro-electric plants constructed at the expense of the licensee in connection with irrigation projects or elsewhere on government domain" (p. 135). The first of these sentences, to be sure, might be construed as referring to "value" in some other sense than commercial value, in which case no circular reasoning might be involved. But the second remark, to the effect that riparian rights must have a value because the government frequently demands a charge for the privilege, is valid only if "value" is taken to mean market value, or earning power. Therefore the inference which Nash draws, as to the right of a public utility to have this "value" included in the rate base, cannot escape the charge of being circular reasoning. Indeed, the author himself would seem to recognize this fact in connection with the similar case of franchise value. For, here too, it has often been the practice of govern-

scribed by statute" which the Court specified. It is difficult, however, to see how this corrected quotation of the Supreme Court dictum offers any escape from the vicious circle. For it is the very validity of the heretofore lawfully prescribed rates which is the question at bar.

ment to charge for the franchise. Yet this fact does not lead Nash to claim that the rate base should include any franchise value in excess of its actual cost.

Unless the preceding comments have seriously misconstrued the implications to be drawn from the recent treatises on the subject, they indicate that only one of the five volumes (that by Bauer) has achieved substantially complete success in developing a theory of a rate base which at no point lapses into the fallacy of capitalizing an assumed earning power. Like the Supreme Court, all of these writers have recognized the danger and have avoided the fallacy in its grosser forms, as for example, when it appears under the heading of a claim for "franchise value." But no less like the Supreme Court they have failed to recognize the fallacy in less familiar dress.

IV

Consistency in the Development of a Valuation Theory

As was indicated at the outset, no opinion will be offered in this review as to the most desirable basis of valuation for purposes of rate control. Cogent arguments can be made for various bases, and no one of them can fairly claim to possess all the advantages. Here the much simpler task will be assumed of noting whether the writers under review are consistent in the development of whatever general principles of value they have themselves accepted. If they have accepted, for example, cost of replacement as the proper criterion, do they hold rigorously to the logic of their own theory in their discussion of various constituents in the total valuation, such as going-value, or interest during construction? Or, if they depart on occasion from their

own general principle, do they give valid justification for making the exception in the particular instance?

The Supreme Court of the United States, it is true, has constantly declined to be bound by any single standard of "fair value." It has hedged itself against the charge of inconsistency by insisting that various factors should all be "considered" and should be given whatever weight is due and proper in each particular instance. This position, whatever may be its practical merits, forecloses scientific discussion, and it has therefore not been accepted by most of the valuation experts, who have felt called upon to write in the language of logic rather than in the language of feelings.

Of the five writers under present consideration, all but one have accepted historical cost (altho with important exceptions to be noted hereafter) as the correct general principle on which to base rates. The single exception is that of Maltbie. Maltbie, however, does not offer any single alternative base as decisive, but on the contrary holds himself free to introduce any of the various "elements" mentioned in the Smyth v. Ames dictum as "evidence" of the "fair present value." These elements include "original cost" (chap. 1), "capitalization" (chap. 2), "market value of securities outstanding" (chap. 3), and "cost to reproduce new" (chaps. 4 to 8). Not all of them, however, are considered by the author to be equally important as evidence of "value." As to capitalization, for example, "few if any commissions have attached much value to it in dealing with a corporation organized many years ago," altho "the precise weight to be attached to this evidence of value has not been determined by the courts" (p. 18). Instead, however, of pursuing this matter further by considering to what extent, if at all, the actual decisions show that rate-making bodies are

influenced by the par values of outstanding security issues, the writer digresses from his subject and spends the remainder of his chapter in an irrelevant defense of bonus stock as a proper financial expedient.

The "market value of outstanding securities" is another element which Maltbie believes to deserve consideration. Most writers, be it noted, would rule this item out as involving circuitous reasoning. But we have already seen that the "not strictly logical" nature of this particular test of values does not prevent the present author from giving it *some* weight. Indeed, he says, "This element is much more important than the question of capitalization, just discussed" (p. 27). Just why it is important, or even at all relevant, is left to the reader to discover for himself.

"Original cost" is a third element for consideration. The author, however, finds the term ambiguous. It suggests the question, "Original cost to whom?" "In ordinary language, when we speak of the cost of an article we mean the cost to its present owner," and the author expresses the opinion that "when one corporation has acquired the property of another in the open market, in accordance with the legal, commercial, and ethical standards of the day, it should be entitled to claim as an investment in such property the cash money paid therefor or the then market value of the securities issued in exchange for the property" (p. 16). It is hardly necessary to note that this "definition" of original cost would result in a capitalization of the expected earning power of the purchased plant in so far as this expected earning power determines the purchase price. Such a basis of rate-making may or may not be valid, but the attempt which the author has made to give it a sanction of respectability by identifying it with the original-cost basis, which has a very different ac-

cepted meaning, is a practice which it is not necessary to characterize.

Judging from the far greater space devoted to reproduction cost new, one may infer that Maltbie regards this as the most important of all the different "elements" in present value. Here, too, however, just as in the case of original cost, he finds the term ambiguous, and he proceeds to find the proper definition. First he points out that cost of reproduction "is not the cost of a different plant capable of equivalent service, but of the existing plant" (p. 30). The former kind of plant would of course be more modern and would be composed of larger generating units. Its total cost per unit of output would therefore be less. "But this fact does not in any way change the amount now invested in the equipment actually in use." This last sentence means nothing unless by "amount invested" is meant the amount actually contributed by the security holders. In that sense the statement is unimpeachable, but what possible bearing can it have on the definition of a rate basis (reproduction cost) which frankly and deliberately *disregards* the actual investment of the security holders? Maltbie's answer would seem to be contained in his remark that "under the other rule [use of reproduction cost of the most efficient substitute plant] few further investments would be made in public service enterprises, since at any time some invention or new process might destroy a large part of the investment." Perhaps this is true. But to the extent that it is true it strikes at the very foundation of the reproduction cost basis, which represents an attempt to allow regulated monopolies to enjoy the same benefits (unearned increment) and to suffer the same losses (depreciation, obsolescence, and so forth) which are supposed to be incurred by competitive business.

But the author still further interprets the meaning of reproduction cost so as to fit his conception of a proper rate base. "Cost to reproduce new is not cost under present physical conditions, but under those existing at the time the plant was created." This definition is a logical derivative from the ruling of the Supreme Court, which, while accepting reproduction cost as at least one important "element" to be taken into account in fixing the rate base, has declined to make any allowance whatever for the estimated cost of repavement over mains where history shows that no repaving costs were actually incurred when the mains were laid.[1] This departure from the logic of reproduction cost (T. R. Powell wickedly refers to it as one of the court's "lapses into common sense") [2] was of course a departure unfavorable to the public service companies. But Mr. Maltbie and the other public utility representatives naturally and properly insist that what is sauce for the goose is sauce for the gander. They point out that public service properties have often been constructed under especially difficult physical circumstances which would not be present if the property were to be reconstructed now. And they therefore insist that the costs to be considered in fixing the rate base are the costs that would have to be incurred at *present* unit prices in order to reconstruct the plant under the *former* difficult conditions. Thus, by insisting that the Supreme Court shall accept the logic of its own illogicality, Maltbie shows that every cloud — even the cloud of the Des Moines Gas decision — has its silver lining for the public utilities.[3]

1. Des Moines Gas Co. v. Des Moines, 238 U. S. 153, 172 (1915).
2. Political Science Quarterly, vol. 40, p. 407 (1925).
3. It should not be inferred, however, that Maltbie himself recognizes the use of historical rather than present physical conditions as a departure from the rule of reproduction cost. Indeed, he carefully

This review of Maltbie's discussion of the basis of valuation has been extended far beyond the point which the significance of the book would justify. No reader with a grounding in economic theory could be misled into thinking that the volume is in any sense a contribution to the science of valuation. Nevertheless I have thought it worth while to indicate in some detail its general drift, because it represents as well as any other example of the recent literature the type of obfuscation which public utility representatives have been inflicting on a long-suffering public in their effort to secure the highest possible valuation on their properties.[4]

In the course of years this literature of special pleading has developed a highly standardized technique. The secret of this technique is the acquisition of skill in dividing value into various elements or factors and of applying to each one of these elements individually, whatever criterion of "reasonableness" will be most likely to result in the highest figure. By this device of segregation it is possible for a skillful pleader to shift his position without attracting attention to the fact

avoids this necessity by defining "reproduction cost" so that it *means* cost under historical conditions. It is not difficult to guess the reason for this distorted definition. The acceptability of reproduction cost (whatever it may mean) as a criterion of "fair value" has become so firmly fixed in legal tradition that any rule which frankly contradicts this basis of valuation must fight hard to overcome a strong judicial preconception. But if, on the other hand, a desired rule of valuation can be defended as being consistent with the reproduction cost basis, in the "proper" sense of reproduction cost, it may then take to itself some of the odor of sanctity which attaches to the prescriptive doctrine. I am aware of no other book in the field of valuation which makes such admirable use of the art of reasoning from definition as does Mr. Maltbie's book. The likelihood that this art is practised quite unconsciously and without the slightest intent to mislead in no way interferes with its effectiveness. Quite the contrary, in fact.

4. A more unguarded statement of the author's interest in a maximum valuation will be found in his recent address before the American Electric Railway Association, where he speaks as "a street railway man" (Aera, November 1925, pp. 741–746).

that he has changed his premises. If, for example, present unit costs of construction are high, attention will be directed by utility counsel to the Supreme Court doctrine that what is desired is "fair *present* value" and not historical costs. But if the present plant is antiquated and if an equally good new plant could be erected at a much lower cost per unit of output, attention is at once diverted from notions of "present values" and is now directed to the fact that the "amounts invested" by utility security holders have not been reduced as a result of the obsolescence of the present plant. In this way public utility representatives have been able to produce, and to defend, that extraordinary hybrid monstrosity, a so-called reproduction cost, defined as "the actual amount necessary to be expended in order to reproduce the *present* plant [not an equally good substitute] at *present*-day prices under the *original* physical conditions." [5]

Turning now to the volume by another representative of the public service industry, Mr. Nash, we come upon the highly significant statement that public utilities, in their own interest, would perhaps do well to forego a claim to a valuation based on reproduction cost and to accept historical cost as the proper principle. This tends to bear out Mr. Justice Brandeis's prediction that with the tendency of prices to fall, public utility investors will suffer rather than gain from the use of the reproduction standard.[6] Nash's striking concession to

5. Maltbie, p. 33. Italics mine.

6. Minority opinion in Southwestern Bell Telephone Co. v. Public Service Commission of Missouri, 262 U. S. 276 (1923). Nash makes some highly interesting estimates which point to the likelihood that actual investment in the local utilities will exceed cost of reproduction by 1938 or thereafter (p. 160). He points out that the date may be brought forward considerably if the courts reduce the reproduction cost figure by an item for accrued depreciation.

the supporters of the actual cost basis of valuation, however, turns out to be by no means as complete as a hasty reading of his book might lead one to infer. For he is not ready to abandon *all* claims to a rate base in excess of the actual cost of the property. Attention has already been called to the author's insistence on the right of hydro-electric companies to add to their rate base an item representing at least fifty per cent of the "value" of the riparian rights, a value to be determined largely by capitalizing the difference between the cost of producing electricity by the present water-power development and the cost of producing it by the most economical substitute (pp. 134, 135). This, needless to say, is a far cry from the actual cost principle of valuation. A second exception which the author seems to make to his general principle is the valuation of land. "Although," he says, "the actual cost of all the property elements is determined from accounting records, as indicated above, it is the almost universal practice in valuation proceedings to ignore this basis of value with respect to land, assigning thereto present value, instead of cost. . . ." This exception, he notes, is "in deference to repeated decisions of the courts that the value of land is its present value" (pp. 117, 118). It may be that Nash is here simply recording the position of the courts rather than registering his own conviction as to the propriety of this practice, but I find nothing in his book which indicates any dissent from the inconsistency.

What is more surprising, however, is that the same inconsistency in the valuation of land appears in two of the books written by impartial experts — Raymond and Lyndon. Both of these authors, while arguing with much force against the use of reproduction cost as applied to the utility plant, nevertheless insist on the

right of a company to include appreciation of land values in the rate base. Says Mr. Raymond: "Probably such appreciation, which is permanent and not the result of mere market fluctuations, should be added to investment cost always, whether investment or reproduction cost is to form the basis of value for rate-making. This is true because such appreciation seems to be a real addition to the investment, not made by investors nor consumers of service, but by those natural causes that add to the value of other property as well as that of a utility" (pp. 273, 274). To many people it would seem that a statement attributing land-value increments to "natural causes" rather than to anything done by the investors would constitute an argument for the very opposite position to that taken by Mr. Raymond. But the writer is apparently so keenly impressed with the fact that investors in other lines of industry get unearned increments that he is led to waive his general principle of historical cost in the interest of this idea of equity. Why this notion of keeping the balance between utilities and competitive industry should be applied only to land valuation and not to the valuation of the whole property remains a mystery to the reviewer.[7]

7. Raymond's position on one point seems to be ambiguous. On page 242 he says: "It may be best to use the 'present' value of land, but if investment is to be the basis for estimating fair return, it is not clear how present value of land can be used unless under periodic valuations the growing appreciation is treated as income." This was the rule proposed some years ago by the New York Public Service Commission for the first District, and its adoption would seem to reconcile the historical cost principle with the practice of appraising land at its "present value." But at a later point Raymond defends the allowance of an unearned increment on the ground that in this way "the utility should be permitted to capitalize its good fortune, and indeed, under the law must be permitted so to capitalize the appreciation of its property" (p. 274). It is hardly necessary to point out that a utility which is required to treat all land-value increments as income (and thus to suffer a reduction on its claim for other net income) can in no sense regard such increment as "a piece of good fortune."

Lyndon bases his allowance of land-value increments, despite his acceptance of historical cost in principle, on the view that it is a kind of "negative depreciation," to be used as a partial offset to positive depreciation.

> In this way [he says] the increase in real estate offsets, in a measure, the decrease in the value of the equipment. This is not a case of taking the reproduction value of the land at all, because it does not constitute an arbitrary change in the value of that portion of the property due to a change in the market prices of metals and labor, but it is a purely normal increase in the actual value thereof. It is of the same general character as the change in the value of the equipment, except that, in the former case, the change is an increase, while in the latter it is a decrease.
>
> That this allowance for the increase in land value is not an equivalent of cost of reproduction is easily seen by considering the result which would follow the liquidation of the utility and the dismantling of the plant. In this case all the equipment would have only the value of second-hand materials and apparatus, but the value of the land would not be diminished (pp. 44, 45).

It is difficult to comment on the above statements with respect to land values, because they seem to involve several concepts which the author has not developed in sufficient detail to make close criticism possible. His distinction, for example, between the "market prices" of metals and labor and the "actual value" of land implies a concept of *intrinsic* value as something different from *market* value — a concept that may well be valid but that needs analysis before it can be taken to mean anything definite. On the other hand, his distinction between the relatively high liquidation price of land and the relatively low liquidation price of equipment and plant (mere scrap value) is true but irrelevant. For why should one attach significance for rate-making purposes to the price at which land could be liquidated while denying significance to the price at which the remainder of the property could be liquidated?

In commenting as above on the treatment of land values by these four writers, the reviewer does not intend either to affirm or to deny the propriety of including lands along with other property at its so-called "present value" as distinct from its actual cost. Forceful arguments can be adduced in support of either side of this moot controversy. What the reviewer does seriously question, however, is the propriety of accepting one basis of rate control (historical cost) "in principle" and then of completely disregarding that basis in its application to one of the most important items of property, land. Whatever may be the faults of the historical cost method, its great strength lies in its stability and predictability. Through its use an investor does not need to guess what the permissible return will be in the future; he can know it in advance by reference to a balance sheet kept on a cost basis.[8] If, however, one important element in the rate base — land — is to be subject to reappraisal consequent on the changing value of adjacent real estate, the very charm of the historical cost method is impaired, while at the same time the full virtues of the reproduction cost method are by means realized. It is one of those compromises that have all the vices and few of the virtues of either extreme.[9]

The last book to be noted in this section is that of Bauer. Alone of the five writers he applies his general principle of actual prudent investment to the property

8. This statement is subject to certain qualifications, especially to the qualification that no return will be allowed if the investment is not deemed "prudent" by the rate-fixing authorities.

9. I am not sure that this criticism applies to Lyndon's treatment of land, since his inclusion of changing land values in the depreciation account would seem to prevent them from resulting in a fortuitous addition to or subtraction from the distributable net income.

as a whole, with no exception for land.[1] He frankly but reluctantly admits, however, that this test cannot fairly be applied without modifications to the valuation of existing property, where the problem of *ex post facto* regulation arises. Here he thinks there is need for compromise and concession, partly in order to make the valuation pass muster with the Supreme Court of the United States, partly in the interest of equity to those investors who have not been put on notice of the precise base on which their return is to be computed. Bauer's concrete suggestions as to the nature of this compromise may or may not win the approval of his readers. The important point, however, is that by means of a differential treatment of present and future investments Bauer has put himself into a position of distinct advantage as compared with the other writers. For he has thus been enabled to advocate a rigorous, uncompromising acceptance of the actual cost basis, as applied to future investments, without running afoul of those considerations of vested interest which have apparently deterred the other writers from the straight and narrow path.

V

Conclusions

This survey has been frankly critical. Certain phases of the problem of valuation have been discussed, not with the thought of suggesting correct solutions but simply with the object of testing the scientific quality of the analysis which recent writers have applied to the subject. On the whole the test is discouraging. With

1. At one important point, however, Bauer's analysis seems to me to be inconsistent with his actual investment theory — his treatment of depreciation. This subject, however, is omitted from the present review, as I hope to discuss it in a separate article to be published within the next few months.

the single exception of Bauer's excellent work, no one of the five most recent volumes shows marked improvement over the earlier treatises either in analytical rigor or in novelty of approach to the problem. To be sure, the general consensus in favor of historical rather than replacement cost is significant. Yet the grounds for accepting this basis are not stated with greater cogency than has been done by its many previous supporters, and the trenchant criticisms which have been made against it by Brown and others have not even been noted, to say nothing of being effectively answered.

In this tendency to repeat the same old arguments, and in this lack of rigor in weeding out the old fallacies, the books under review are fairly typical of the vast output of articles, attorneys' briefs and judicial decisions which is being added every year to the literature of public service regulation. It would seem that the subject of valuation has come into a stage of stagnation — into one of those mysterious plateaus which, psychologists tell us, are characteristic of the learning curve. Some students of public utility problems have become so keenly aware of this fact that they have broken away from the largely sterile discussion of valuation and have approached the subject of rate-making from a different point of view. An example of this tendency is C. S. Morgan's volume, *Regulation and the Management of Public Utilities* (N. Y., 1923). Morgan treats the problem of rate-making primarily from the point of view of its effect on managerial efficiency. He touches only lightly the subject of valuation, and as a result of this fresh approach, he makes a decided contribution to the theory of rate regulation. His example is well worth imitating. Yet while the subject of valuation can properly be side-stepped in this way by those who wish to throw light on other aspects of rate control, it cannot

be escaped permanently in any effective solution of the problem as a whole. Even the question of rewarding managerial efficiency is bound up with the question of the general rate base, and the two issues cannot be settled independently. The only way, then, to relegate the problem of valuation to the background of the science of public utility control is to solve it.

For this reason the question how to break the spell of stagnation which for several years has lain over the subject of valuation is a question of prime importance. In the reviewer's opinion the answer is fairly simple. One must divide and conquer. The trouble with most of our discussions of valuation has been that we students have treated the matter as if it involved the single problem of finding the "fair value" of a public utility property. In reality, however, valuation involves a number of different tho related problems, each of which can be treated intelligently only if treated separately. This review has already suggested two different ways of breaking up the whole into its component parts. First, we must distinguish between the problem of retrospective valuation, where the question of *fairness* arises, and the problem of prospective valuation, where the question of *fairness* is not properly a deciding factor in the choice between alternative methods of rate control. Second, we must distinguish between valuation as a basis of regulating profits and valuation as a basis of regulating the charges for service, and we must not assume without convincing evidence the existence of any "natural law" which makes these two objects of control coincide. To these two sets of distinctions a third may well be added, not yet mentioned in this review. We must scrutinize any suggested rate base, first, from the point of view of its effectiveness in attracting capital from investors, and second from the point of

view of its effectiveness in securing efficient and economical plant construction. It is by no means certain that the better basis from the first point of view is not the worse basis from the second.[2]

In this insistence on the necessity of a sharp division of issues, the reviewer by no means wishes to imply that a separate rate base is feasible or even possible for each one of the multifarious functions which such a base is designed to perform. On the contrary it may even be — altho this seems to me highly doubtful — that a single method of appraisal, such as original cost, or reproduction cost depreciated, or a fifty-per-cent compromise between the two, should be applied in the future, as it has generally in the past, to old property as well as to new, and to the regulation of charges as well as to the regulation of profits. What is here asserted is simply the necessity of breaking up the subject along functional lines for purposes of analysis. If, after doing so, we still decide to compromise on a single rate base, our compromise may then rest on an intelligent choice instead of resting, as it does now, on an uneasy, half-conscious awareness of the presence of conflicting considerations.

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2. As a means of attracting capital, actual cost, with its freedom from uncertainty and fluctuation, may well take first rank. On the other hand, as a means of encouraging economical plant construction during times of low prices, reproduction cost has something to commend it. This point is well brought out by F. G. Dorety in one of the few really cogent defenses of the reproduction cost basis that have yet been published: "The Function of Reproduction Cost in Public Utility Valuation and Rate Making," Harvard Law Review, vol. 37, pp. 173–200 (1923).

NOTES AND DISCUSSIONS

EARLY HISTORY OF THE TERM CAPITAL

In an article under the above title in this Journal for May 1921 (Vol. XXV, No. 3) Professor Edwin Cannan refers to the fact that the first examples of the use of the economic term "capital," or rather "capitall," that have been discovered in English literature occur in treatises appertaining to accountancy. He quotes in this respect (1) a passage containing the phrase "proper stocke or capitall in trafique" from James Peele's *Pathe waye to perfectnes*, published in 1569, which he states he has obtained from a footnote in Professor W. R. Scott's *Constitution and Finance of English, Scottish and Irish Joint Stock Companies;*[1] (2) a single sentence — mentioning as his authority for this Murray's New English Dictionary, the Oxford Dictionary, or N. E. D. — "the remaine is the net rest substance or capitall of the owner," from another Tudor treatise published in 1588, which he calls the *Briefe Instr* of J. Mellin[2] — "a writer," adds Professor Cannan, "about whom I have not yet ascertained anything"; and (3) the following excerpt from Richard Dafforne's *Merchants Mirrour*, first published in 1635, which

1. Vol. i, p. 60.
2. Professor W. R. Scott, op. cit., vol. i, p. 60, footnote 1, states, "In Murray's Dictionary the following references are given: 1588, J. Mellin's Brief Instr. B. II. b. 'The remaine is the net rest, substance or capitall of the owner'; 1611, 'Capital — wealth, worth, a stocke, a man's principall or chief substance.'"

The sentence from Briefe Instr. does not appear in Murray's New English Dictionary under "Capital," B. 3. vol. ii, dated 1893, p. 93. The earliest reference quoted in this section, which has not since been amended, is the second one given by Professor Scott, dated 1611, taken from Randle Cotgrave's Dictionarie of the French and English Tongues, 1611 edition, Brit. Mus., 828. p. 15.

he terms an "instruction": "No. 96 to booke the capitall which each partner of a joint company promiseth to bring in:

Simon Sands promiseth into the company for his stocke... gl 11,400
And Richard Rakes for his stocke intendeth..... gl 7,800

gl 19,200."

Professor Cannan seems to have been led astray by a misprint. No such writer as "J. Mellin" existed. The surname Mellin should have been written Mellis, for the second of the preceding quotations is taken from a treatise entitled *A Briefe Instruction and Maner how to keepe bookes of Accompts after the order of Debitor and Creditor, and as well for proper Accompts partible*, published in 1588.[3] Mellis, as will be shown later, was not the original writer of this book; he was responsible for the enlarging and correcting of an earlier edition.

James Peele and John Mellis were two of the Tudor pioneers of the so-called accountancy "after the Italian manner," at that time newly introduced into England. Peele's *Pathe waye to perfectnes*, which appeared in 1569, was regarded by both Adam Anderson and David Macpherson as the first treatise on accountancy published in England. "Everything in this century," writes Anderson, under the year 1569, "tended to improve in a mercantile sense. The author has in his possession the first work ever published in England on the art of Italian merchants-accounts, or Book-keeping by Double Entry; it is a folio printed at London, in the year 1569, in a black letter, the author James Peele." [4] Macpherson confirms part of the latter portion of this statement, for under the date 1569 he informs us that "the first English book on the Italian art of keeping merchants' accounts, or book-keeping by double entry was published by James Peele (London, 1569)." [5]

Anderson and Macpherson are, however, inaccurate.

3. Brit. Mus., 712. a. 39.
4. Adam Anderson, An Historical and Chronological Deduction of the Origin of Commerce, 1787–1789, vol. i, p. 130.
5. David Macpherson, Annals of Commerce, Manufactures, Fisheries and Navigation, 1805, vol. ii, p. 149.

There is in the British Museum a copy of an earlier English accountancy treatise written by James Peele, published in 1553, which is entitled *The maner and fourme how to keep a Perfect Reconyng after the order of the most worthie and notable accompt of Debitour and Creditour, set foorthe in certaine tables.*[6] The book is dedicated to "Sir William Densell Knight, Treasurer of the Quenes Maiesties Wardes, and Gouernoure of the most worthie and famous compaignie Marchaut aduenturars: and to al the worshipful felowship of the same." In the dedication Peele states that he has "folowed therin the most easie and best waye that euer I perceived amongst marchauntes, euen the trade (as I thinke) that is used in Venice and other places. I am compelled to say with Peter," he adds, "golde and siluer have I none, but that which is mine I do willingly geue unto you A true, ready and perfect order in accomptes for the trade of marchantes."

There is no reference to the term "capitall" in Peele's first book. In Chapter II, however, which explains "the Inuentorie," the word "Substaunce"[7] occurs and this term appears to be the forerunner of the word "capitall" in the early English accountancy treatises. "At thende thereof," (that is, "the Inuentorie") writes Peele in this particular section, "make in like maner a somme total, which somme by thowner due to other, you must subtrate from the other Totall, and the remain is the substaunce of the owner, whiche remain must in one totall somme, with express woordes be set out large."

This may be compared with the first appearance of the term "capitall" in the book entitled *A Brief Instruction*, etc. (Chapter III) issued by John Mellis thirty-five years later, in 1588. The phrase in which this occurs is given by Professor Cannan, but not the context, in which is described "the forme and maner of keeping a solempne Inuentorie" the concluding part of which reads thus — "Thẽ gather together

6. Brit. Mus., 8223. c. 16.

7. In the third of the sample pages of book-keeping entries given in this treatise the following entry appears: "The rest taken on creditors side, is the owner his nete substaunce, beyng borne to balance in folio, — 15 . . . 1569 l. 17s. 08½d."

the whole summe of your ready money, debtes and goods, And therefrom Substract the totall summe of your Creditours, and the remaine is the net rest, substance or capitall of the owner to be put in a trafique."

In Peele's first book the term "stocke" occurs in the fourth chapter, which deals with the Journal. "Then," it is stated, "as touching the enteryng of your Inuentorie, into the Journall, as the order of this accompt requireth, you shall in eche parcell of the said Journall, expresse two denominations: whereof the first shalbee the name of the Debitour, receiuour, or borower, and the other of the Creditour, deliuerer or lender, this being considered, entre your first parcel, which is money debitor to your stocke, saiying: Money is Debitour to stocke belongyng to me Fraunces Bond of London, Grocer, and is for 270 Angelles therein valued at tenne shillynges the Angell, amountyng to the somme of one hundred thirtie and fiue poundes. I saie . . . 135 li." In the eighth chapter in a description of the "Balaunce" we are told that "if ye subtract the creditours, the remain is your substaunce at this present and is proceded of your stocke, first put in, and your profite, which by good reason must needs be so." Chapter IX tell us "what is to be done of suche as will have their substaunce kepte in secrete." The first part of this treatise contains "instructions" divided into chapters and the second or practical part a number of sample book-keeping entries as a supplement. The first entry in the practical part reads thus — "Monie is debitor to stocke for clxx aungels therein valued at x.s the aungel amounteth one, cxxvl." The term "stocke" occurs frequently among these specimen entries.

Peele's second book, *The Pathe waye to perfectnes*, is a much larger volume than his first attempt; and the British Museum copy is in an excellent state of preservation.[8] The

8. In Richard Dafforne's Merchants Mirrour, Ralph Hanson, accomptant, in a short introductory section "touching the author and his work," which immediately follows the "Epistle Dedicatory," states that "it is true, that divers have well written of this subject in *Italian, French Spanish, Dutch*, and in *English;* Master *James Peele* a Citizen of London is no way inferiour to the rest: but we are more addicted to extoll the works of strangers than those of our own Country."

full title of this work is *The Pathe waye to perfectnes in th' accomptes of Debitour and Creditour: in maner of a Dialogue, very pleasaunte and proffitable for Marchauntes and all other that minde to frequent the same: once agayne set forthe, and very much enlarged By James Peele Cittizen and Salter of London, Clercke of Christes Hospitall, practizer and teacher of the same.* It is dated August 16, 1569. Had Anderson carefully perused the copy of this treatise which he had in his possession he would not have committed the error, repeated by Macpherson, of stating that this was the first English accountancy book. The words "once agayne set forthe" in the preceding title point to a previous volume, while in the preface Peele refers specifically to his first volume "whiche before this," he writes, "I once published and sett forthe, though not in suche large and ample manner: yet was it founde proffitable to manye, which are fallen into the use thereof."

The description of "an Inuentorie for trafique" quoted by Professor Cannan from Professor W. R. Scott's footnote occurs in the second part of this book entitled "A dialogue between the Scholemaster and the Scholler, wherby is taught the maner to keepe bookes of reconinges for marchauntes by thorder of debitour and creditour . . ." The "Scholemaster" referring to the inventory says: "then substracte the some totall of the creditours from the totall some of money, debts, and goodes, and the remayne is the net substaunce, stocke or capitall by thowner put in trafique of marchaundise . . ." It will be observed that this resembles the latter part of the quotation from the accountancy book issued by John Mellis. The term "rest," however, is absent, while the term "stocke" is introduced.

A little later in the same dialogue we find the phrase "capital stock." The section in which this occurs reads thus:

Scholemaster. — Have you in mynde what the last thinge was whiche I taught you in the same Inuentorie?

Scholler. — Yes, sir, very well.

Scholemaster. — What was the same? declare.

Scholler. — The last thinge thereof, was the substracting or

takinge out the somme totall of the creditours, from the totall somme of the money, debtes and goodes, and the reste which proceaded thereof made playne and manifest the stocke, or capitall, which (as before) the owner of thaccompte hath in trafique of marchaundise committed to thorder of his seruaunt.

Scholemaster. — Yea saye trouthe, it was so in deede. Nowe if you remember, directlye before the sayd somme of the capitall stocke in the Inuentorie towardes the righte hand, and at the verye latter end of the same Inuentorie, there is drawen a directe lyne with a hand poyntinge thereunto, under the whyche lyne, standeth the figure of 1. on this maner $\frac{0}{1}$, and is to declare that the same stocke or capitall is borne ouer into the Leager or greate booke of accomptes, to the creditour syde there, in folio 1, and there is made creaditour, under the title of stocke of employmentes for trafique in Marchaundise.

John Mellis,[9] mathematician, as he is described in the British Museum General Catalogue, was a "Scholemaster" of Southwark. He was evidently well known in Elizabethan times, for he edited two valuable treatises and also wrote important additions to the new editions. The first of these was the famous mathematical work of Dr. Robert Recorde entitled *The Grounde of Artes, teaching the perfecte worke and practice of Arithmetike*,[1] a standard Tudor treatise which ran into many editions.[2] On the title-page of one of these edi-

9. A curious error occurs in the Dictionary of National Biography. A short biography of John Mellis, by Thompson Cooper, is given under the heading of "Mellis, Hugh (fl. 1588)."

De Morgan — Arithmetical Books (1847) — p. 28, states that the Brief Instruction, etc. "is the earliest English book on book-keeping by double entry which has ever been produced."

1. W. Massey, The Origin and Progress of Letters (1763), p. 16, mentions that Mellis in his "Epistle Dedicatory" in the 1594 edition of Recorde's Grounde of Artes, states that he was a Norwich man. There is no reference to this in the "Epistle Dedicatory" of the 1582 edition (Brit. Mus., 8534. a a. 34) the title of which is as given above. It is, however, stated in the said Epistle that Mellis served Dr. Robert Forth one of the "Maisters of the Queenes Maiesties high Court of Chauncerie" when he was at Cambridge and at the same time attended the "Arithmeticke Lecture in the common Schoole."

2. Dr. Robert Recorde, like a good number of the remarkable men of the remarkable age of the Tudors, was of Welsh extraction. An interesting biography of Recorde by W. F. Sedgwick appears in the Dictionary of National Biography where it is stated that editions of The Grounde of Artes were published in 1540, 1542, 1543, 1549, 1551, 1552,

tions, dated 1582, preserved in the British Museum, it is stated that the book has been augmented by John Dee and "now lately diligently corrected and beautified with some newe Rules and necessarie Additions; and further endowed with a thirde part, of Rules of Practise, abridged into a briefer methode than hitherto hath bene published; with diuerse such necessary Rules as are incident to the trade of Merchandise. Whereunto are also added diuers Tables and instructions that will bring great profite unto Marchants Gentlemen, and others, as by the contents of this treatise shal appeare. By John Mellis of Southwarke Scholemaster." [3] In this particular edition Recorde's section of the work extends to page 404. The "thirde part, of Rules of Practise" and the "diuers tables and instructions" are original contributions by Mellis, extending from pages 405 to 557.

In 1588 *A Brief Instruction*, etc., was published. This treatise was originally compiled by Hugh Oldcastle, "Scholemaster," and first appeared in 1543, but no copy of the original issue appears to exist. It would be interesting to know whether or not Oldcastle used the term "capitall" as early as 1543. The 1588 edition was revised by Mellis. In the preface he states that he is but the "renuer and reuiuer of an auncient old copie printed here in London set forth by one Hugh Oldcastle Scholemaster" of "Saint Ollaues parish in Mark Lane." [4]

1561, 1570, 1571, 1573; with additions by John Dee and John Mellis, 1582, 1583, 1590, 1600, 1607, 1610; by Robert Norton, 1618; by Robert Hartwell and R. C., 1623, 1636, 1646, 1648, 1652, 1654; by Thomas Willsford, 1658, 1662; and the last known edition by Edward Hatton in 1699.

The following editions are preserved in the British Museum: — 1543, (G. 16099); 1561, (C. 31. b. 22); 1582, (8534. a a. 34); 1607, (8506. b b. 21); 1623, (8506. b b. 21); 1632, (531. e. 41); 1636, (8505. a a. 51); 1686, (8532. a a a. 22); 1652, (531. d. 18); 1658, (8532. a a. 24); 1662, (1394. a. 16); 1699, (8530. f. 36).

3. In the 1607 edition the same sub-title appears minus the words "of Southwark, Scholemaster." On the title-page of the Brief Instruction, etc., the words "by John Mellis Scholemaister" appear.

4. The Brief Instruction, etc., is to a great extent a translation of the oldest known treatise on accountancy, Lucas Pacioli's Particularis de computis et scripturis, which forms Section IX, Treatise XI, of this writer's Sūma de Arithmetica, Geometria Proportioni et Proportionalita,

The *Brief Instruction*, etc., is a very much smaller book than Peele's *Pathe waye to perfectnes* and in the 1588 edition two original contributions have been added by Mellis. One is referred to as "a little Inuentorie, Journal & Leager" where samples of accountancy entries are given, and, the other is entitled *A Short and Plaine Treatise of Arithmeticke in whole numbers*, containing 53 folios.

As already stated the term "capitall" first occurs in the third chapter of the *Brief Instruction*, etc. It is again used in the heading of the tenth chapter thus, "Of the manner of knowledge, the enditing of parcelles into the Journal, as well the Debitor, as the Creditor, and of two other termes used in the Leager; whereof one is named Capsa and that other Capitall, and what by them is to be understood to wit, Debitor and Creditor."[5] Then follows a curious and interesting explanation of the difference between the terms "capsa" and "capitall." "First in the name of God," it is stated, "you shall enter or indite into your Journall the first parcel of your inuentory, that is to weete, the parcell and summe of ready money, golde and siluer, and for the more knowledge of the entring and ordring of parcels of the Inuentory into the Journall, yee shall call to remembrance the aforesaid two terms Capsa and Capitall: and by Capsa is understood the chyst or ready money, and by Capitall is understoode the substance of a mans goods, or his stocke,[6] which stocke shal

first published in Venice in 1494. The British Museum possesses two copies of this work, the first edition (IB. 23272) and an imperfect edition dated 1523, (513. m. 17). A comparison of Pacioli's accountancy treatise with the revised edition issued by Mellis shows that Oldcastle omitted eleven chapters of the original Italian work. The remaining chapters of the Particularis de computis with certain alterations and additions, form the contents of the Brief Instruction, etc. Among the additions is the concluding part of Chapter III already quoted.

5. In the Particularis de computis, *capsa* appears as *cassa* and "capital" as *cauedale*. Pacioli also uses the terms *cassa* and *cauedale* in the title of his fifteenth chapter; but in the title of the corresponding chapter in Oldcastle's book the equivalents of these terms are given as "chyst" and "stock."

6. A more literal translation of Pacioli's definitions would read thus: "By cash (*cassa*) is understood your share or purse (*borscia*) and by capital (*cauedale*) all that you now possess."

always bee Creditor as well in your Journall, as in your Leager, and the chyst or ready money Debitor."

Richard Dafforne, the third of the early writers on accountancy mentioned by Professor Cannan, resided during part of his life at Northampton and was a teacher of accountancy "after an Exquisite Method in the English and Dutch Language." He published two treatises dealing with book-keeping "after the (so tearmed) Italian manner" — *The Merchants Mirrour*,[7] first published in 1635, and *The Apprentices Time-Entertainer Accomptantly; or A Methodicall meanes to obtain the Exquisite Art of Accomptantship* [8] in 1640. The former of these books, a very detailed and well-written treatise, was a standard work, reissued on at least three occasions in the seventeenth century. Both treatises give a great deal of valuable information about the monetary and mercantile transactions of the day.

The excerpt, already mentioned, containing Dafforne's use of the term "capitall" quoted by Professor Cannan, occurs in that part of the *Merchants Mirrour* devoted to practical examples in accountancy and is a book entry numbered 96 in the section which illustrates the method of posting one of the so-called "Waste Books." Dafforne's introduction in this treatise is in the form of a dialogue between two characters called "Philo-Mathy" and "School-Partner." This is the explanatory portion of the book and contains 250 num-

7. The following editions of The Merchants Mirrour annexed to Gerard de Malynes's Lex Mercatoria are preserved in the British Museum: 1651, (515. k. 26); 1660, (709. i. 3. (1)); 1684, (509. h. (4)). Of these the 1660 issue is stated on the title-page to be the 3rd edition corrected and amended.

De Morgan, op. cit., p. 50, under the date 1684, gives the following: "Richard Dafforne, 'The Merchant's Mirrour' Folio in twos. A book on book-keeping, translated from the Dutch."

In this book the "Epistle Dedicatory" is signed "R. D. of *Northampton*." The writer states that he had resided for many years in Amsterdam but that he resolved "to pitch" his "tent" in London in 1630. We are also told in the same "Epistle" that the ignorance of book-keeping in England had "emboldened" him "to prepare this Antidote, being by nature obliged to offer up part of the Widows Mite of my knowledge unto the Land of my Breaths first drawing."

De Morgan gives no details of any other editions besides that of 1684.

8. Brit. Mus., 1394. h. 28.

bered sections dealing with the method of book-keeping. These sections are really the "instructions" and No. 96 contains no reference to the term "capitall," neither does paragraph 96 in the "Brief Contents of the chiefest Points contained in this Book" which precedes the introduction.

It is interesting to note, before concluding this brief article, Dafforne's ingenious explanation in the *Merchants Mirrour* (p. 9), of the term "stock," which he spells in two ways. The dialogue reads thus:

> *Philo-Mathy.* — One other Question I have to demand before you proceed, which is, Why is *Stock* made *Creditor?*
>
> *School-Partner.* — Because the word *Stock* containeth in it, all what a man possesseth; whether *Money, Wares, Debts* due to us, or the like; and (marke this well) *Cash*, yea, each particular thing that I possesse, is but a member of that whole body *Stocke;* therefore by the joynt meeting of all those members, the body (*Stock*) is made compleat.

R. D. RICHARDS.

LONDON, ENGLAND.

THE DECLINE OF TRAMP SHIPPING

FACTS have a tendency to develop faster than theories. Consequently, theories must be taken periodically from the cold storage to which static things are consigned and remodeled in the warm light of recent events. Developments in shipping during and since the war together with the completion of some recent research studies make it advisable to reconsider the implications of the competition between liners and tramp ships.

The ocean-borne trade of the world is carried by ships in regular services and by tramps. Liners ply between terminals almost as regularly as railroad trains. Tramps, in contrast, have no fixed routes or regular sailing schedules, but go from port to port wherever cargo offers. The demand for ship tonnage varies because of the seasonal nature of crops and the needs of commerce. It is this irregular movement of cargo which calls for tramp ships. Steamships in liner trades are operated by their corporate owners; tramp ships are

chartered for single voyages or on the time basis and are offered for hire to anyone who desires to move shiploads of cargo. The chief distinction between the tramp ship and the liner is in regularity of employment. Structurally each type merges into the other. The liner furnishes service in times of prosperity and depression. The tramp ship offers itself at times and places where the demand for transportation exceeds the facilities offered by liners. It is the drudge of the seas, carrying the dirty and bulky cargoes which have great weight or size in proportion to value.

Tramp ships were considered to outnumber liners before the war and to account for the largest part of the ship tonnage of the world. The general idea on this subject was derived in part from a study made by Sir Norman Hill, the secretary of the Liverpool Steamship Owners' Association, in which he pointed out that British liners in oversea trade in 1913 amounted to 1,200 ships aggregating 4,200,000 net tons and tramps to 2,400 of 5,700,000 tons. In other words liners were one-third of the number and forty-two per cent of the tonnage of the British merchant fleet. This figure of one-third liners and two-thirds tramps struck the popular fancy and became imbedded in common knowledge. The statement was true only of British ships. The fleets of other countries, especially those of Germany, Italy and France, even before the war, were largely made up of liners. Further, liners are usually much faster than tramp ships. If an average speed of eight knots is assumed for general trading vessels and 16 knots for ships in liner services, British liners in 1913 would have contributed sixty per cent of the space available to shippers on the routes served by them. This percentage can logically be considered as a minimum for the shipping of all countries.

In 1922, liners furnished eighty-one per cent of the total space for cargo and passengers offered by the ships in trans-oceanic trades, according to an analysis recently made by Mr. Eugene T. Chamberlain of the U. S. Department of Commerce. It was impossible to separate the space reserved for passengers from the space reserved for cargo on the large

passenger-cargo liners, but an estimate indicates that the percentages given below would not be changed more than two or three points by this factor. The following table gives the results of this study. The tonnage figures are given in thousands of net tons of clearances with cargo and are based on an examination voyage by voyage of the ships active in 1922. Since every ship usually makes a number of trips a year, net tons of clearances with cargo is a better figure to use for present purposes than the gross or deadweight tonnage of the ships. The use to which ships are put rather than their aggregate tonnage is the measure of their usefulness.

CLEARANCES OF SHIPS WITH CARGO, 1922
(Thousands of net tons)

Route	Total	Liners	Per cent Liners
N. America to Europe	25,832	20,796	80
N. America to S. America	2,016	1,709	85
N. America to S. Africa	294	208	72
N. America to Australia	845	652	77
N. America to Asia via Panama and Suez Canals	1,390	1,205	94
N. America, Pacific Coast, to Asia	2,852	2,139	75
Europe to Asia (Suez Canal)	6,384	6,107	95
Europe to S. and W. Africa	1,926	1,519	80
Europe to Australia	2,060	1,802	87
Europe to S. America	5,918	4,379	74
Total	49,517	40,516	81

This decrease in the proportion of facilities offered by tramp ships has been due to several causes. In the first place there has been a decided tendency toward specialization in types of ships. At one time, most of the oil of the world, both refined and crude, was carried in containers. To-day 961 tank ships aggregating 5,157,000 tons carry in bulk most of the petroleum and petroleum products in oversea trade. Large fleets of fruit ships on regular schedule now transport tropical fruits in international commerce. A few cargo ships are still chartered to carry bananas from Central America to this country, but the percentage of loss is so high when shipments

are made in this way that the specialized types have practically driven out the tramp.

Another cause of the decline of the general trading vessel is the increase of industrial carriers, vessels owned by corporations and carrying largely or wholly the products of such organizations. The most striking example in this country is the large fleet of the United States Steel Products Corporation which operates, under the trade name of the Isthmian Line, 37 modern cargo ships. Before the World War this corporation was a frequent charterer of tramp ships. The Bethlehem Steel Corporation's combination ore and oil carriers illustrate not only the tendency toward industrial carriers but also toward specialization of types. Other examples are the Coastwise Transportation Company's fleet of colliers and the Texas Gulf Sulphur Company's special sulphur carriers. Both coal and sulphur were formerly largely carried in tramps.

A third factor has contributed. The increasing specialization and interdependence of world trade which has resulted, in part, from improved and rapid communications, has placed a new emphasis upon regular and frequent steamship services. Such services can be depended upon only from large, established steamship companies. The traders of the world, especially in the postwar boom and collapse, had unfortunate experiences with new and too frequently irresponsible steamship lines. As a result, shippers prefer regular lines, and fewer tramps are chartered and placed on berth.

Another trend in line with the last-named may be mentioned. Merchandising methods have changed materially since the war. The impoverishment of certain countries and the wide fluctuations of foreign exchange rates have caused orders to be placed in small quantities for immediate shipments and stocks to be reduced to a minimum. Two examples will suffice. Before the war practically all the lumber trade out of the Gulf to Europe was in tramp ships. Part of this was due to the absence of sufficient liner services and part to the practice of European customers in keeping large stocks. Since the war Europe has been buying from hand to mouth.

The Shipping Board has established several liner services out of Gulf ports to Europe. Few ships are now chartered to carry lumber from the Gulf across the North Atlantic. Similarly in the grain and flour trade of the North Atlantic the tendency is toward smaller and more frequent shipments. In 1924 over eighty per cent of the grain out of New York went in parcel lots by liners. In recent months it has been difficult to find record of grain charters in this area for the purpose of keeping up an index number of trip charter rates.

This change in merchandising methods has not been the sole cause of increased liner inroads on tramp ship trades. The very success of the increased liner services has been partly responsible for the change in merchandising methods. The two forces have interacted, but the outstanding fact is that a large part of the grain and lumber in oversea commerce (two commodities formerly carried almost entirely in tramps) is now handled by liners.

The current theory of the effect of tramp ship competition on liner rates is well expressed in the quotation from the president of a large shipping company, found in Johnson and Huebner's *Principles of Ocean Transportation*. "Neither the large nor the small shipper is ever at the mercy of the steamship lines if rates advance to a point which may be thought to be unreasonable. If the rates exceed or even approximate the rates at which tramp steamers can be chartered, large shippers of special commodities immediately protect themselves by the employment of tramps for the transportation of their shipments; and small individual shippers, who cannot accumulate merchandise in quantities sufficient to justify the chartering of tramp steamers are at such time served by chartering brokers, who are always ready, when rates by the regular lines advance to such a point that a profit can be made by chartering, to lay chartered steamers on berth, themselves accumulating the shipments of numbers of small merchants, who by this means can always protect themselves against oppression."

The facts scarcely support this optimistic opinion of the tramp ship as a regulator of ocean freight rates. For the

reasons mentioned above, especially the development of industrial carriers and the preference of shippers for established services, the tramp ship and liner come into competition only in the case of a few commodities which move in bulk. Liners frequently find it impossible to fill their holds with the more profitable high-class freight. In order to make use of space which would not otherwise be utilized, they bid for certain commodities which would normally move in full shiploads. These commodities are called "berth cargoes" and the rates made on them by liners are called "berth rates." The berth cargoes commonly obtained at New York for European destinations are grain, cotton, cottonseed oil, provisions and sack flour. Out of southern ports additional berth commodities are rice, pine, hardwood, rosin and turpentine.

It will be noted that these commodities move in bulk. Individual shippers usually have large lots of them for shipment. The exporter who has only a small shipment of a few dozen cases of goods has no alternative but to use liners which specialize in handling many lots of small shipments. A shipper of typical tramp commodities, on the other hand, usually has enough of these commodities to take up all the capacity of a ship and consequently has the choice of chartering a ship or of shipping in lots by liners. Usually he will charter a tramp ship because this method of transportation is cheaper. But in a large port where many liners call, there will ordinarily be a good deal of surplus liner space which the shipping companies have not been able to fill with high-class freight. Liners must sail, even if some space is unused, or they may take what extra cargo they can obtain at any rate above handling charges. Since the shippers of grain, cotton, and so forth normally have sufficient cargo to fill a chartered ship, the liner in order to get these commodities must come into direct competition with tramp ships. This competition means that the liner must quote rates approximating those prevailing for tramp tonnage.

It will be noticed, however, that berth cargoes carried by liners represent an encroachment of the liner into the domain of the tramp. The tramp is not the aggressive agent, as many

believe, but seems rather to be everywhere on the defensive. On the other hand, the competition of the tramp ship for the high-grade cargo which moves in liners is negligible. In many cases a liner company charters tramp ships to fill out or increase the frequency of its schedules. In such cases the tramp by definition ceases to be a tramp and becomes a liner. Except for the restrictions self-imposed on steamship companies through their conference agreements and the regulatory sections of the Shipping Act (1916) and the Merchant Marine Act (1920), which have never been enforced, there is for the American shipper no control over ocean freight rates. It is in the question of rates that the relation between the liner and the tramp is of general significance.

In Great Britain the Imperial Shipping Committee, an informal body appointed by the home and colonial governments, has been set up to handle the complaints of shippers. The British method is to have shippers' and shipowners' organizations settle their disputes around the table. If they fail to agree, the case is then brought before the Imperial Shipping Committee, which investigates and recommends. The committee has no powers of enforcement other than persuasion. In Canada, shippers have brought charges against the North Atlantic Conferences and are seeking to have the Government abolish them. In this country, through the Shipping Act, and the Merchant Marine Act, Congress has tried to set up a control over ocean freight rates comparable to that exercised over rail rates by the Interstate Commerce Commission. Many authorities believe, however, that the regulation of rates of shipping companies which have termini in two countries is outside the scope of domestic legislation.

In other words, the growth of liner organizations is bringing forward the necessity for some control over ocean rates. It appears that this control will have decided international bearings. Friction may result, since it is probable that the interests of a country whose ocean-borne trade is large in proportion to its merchant fleet, such as the United States, will be at variance with those of a country whose merchant fleet is large in proportion to its ocean-borne trade, such as Great

Britain. Solution of this problem will be slow, not because it is extremely difficult but because it is new.

Another effect of the tendency away from tramp-ship methods is that any discriminatory action on the part of one country is likely to be nullified. Tramp ships are more sensitive to discrimination than liners because tramps get their cargo on a competitive price basis. Any action which gives an advantage to the ships of one country immediately rules out the general trading ships of other countries. The liners, on the other hand, since they uniformly belong to conferences which control rates, do not operate on a purely price basis. It is consequently easier for a liner to absorb a differential imposed by the discriminatory action of one country.

The pronounced trend toward liner services has made it possible for discriminatory actions to be neutralized in another manner. When hearings were being held on section 28 of the Merchant Marine Act (which is to the effect that all import and export rail rates lower than the domestic rates in the same direction and for the same distance shall apply only when the goods are carried in American vessels) it was the general opinion that the application of the section would not help our ships in the Atlantic trades because the conferences in this region were dominated by foreign lines. These foreign lines, it was argued, would force the numerically weaker American lines to absorb the artificial differentials created by section 28. It is difficult to see how the steamship lines of any one country could withstand the combined pressure of the lines of all other countries in a conference. It is equally difficult to see how the lines of any one country outside a conference could withstand the competition of the lines of all other countries in a conference. Some observers are of the opinion that the preponderance of the liner to-day makes discriminatory action on the part of any one country more unprofitable than formerly.

On one assumption, however, a country might succeed in employing discriminatory measures in favor of its shipping, that is, through government ownership and operation of vessels. In a recent congressional hearing a suggestion was made that the lines of the Shipping Board withdraw from all con-

ferences and carry cargo for $2 a ton or for nothing, if necessary. The scheme advocated in Canada for the breaking up of the conferences in the North Atlantic is that the Government heavily subsidize a new trans-Atlantic line on condition that it stay out of the existing conferences. The declared purpose of the Australian Government in maintaining government-owned services after the war was to fight the existing conferences. Australia, however, has now given up its public ships. The Canadian Government has stopped the hearings on the proposal to subsidize a new trans-Atlantic line. The United States is making progress in liquidating the government fleet. Shipping is slowly returning to its previous status of a private industry.

To sum up: the recent tendencies in shipping seem to call for revision of our old theories and to make necessary changes in some of our policies. Before sound theories or policies can be evolved, much more research into the details of shipping is essential. The present article in the nature of the case is not conclusive, but the writer hopes that it may be suggestive and lead to further research.

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A CORRECTION

THE review by Professor Ripley, which appeared in this Journal for November 1925, contains certain statements about our volume, *Railroads: Rates, Service, Management*, which are erroneous.

In the first place, he states that the various books under consideration "devote all of their attention to the total through rates, entirely forgetting that it is in fact the portion of this through rate falling to each and every one of the single companies which determines whether it shall be self-supporting or not." The fact is that in Section 4 of Chapter XXIV, shown in the Table of Contents as "The Division of Joint Rates," we do discuss this subject.

In the second place, he states that we (and the others) did not "apparently even suspect the interrelation between routing and rate division." This statement is also erroneous; for the subject is discussed in Section 4 of Chapter XVII of our book, shown in the Table of Contents as "The Division of Through Rates."

In the third place, Professor Ripley states that only one of the authors (Professor Haney) "does so much as brush the topic" of terminal developments. In fact, however, we discuss terminal problems at considerable length in our Chapter XVIII, entitled "Terminals and Terminal Facilities."

Finally, he says that "nowhere may one find any discussion at all of such topics as reciprocal switching, closed and open terminals, interchange operation, and especially unification of terminals." These topics — with the possible exception of "reciprocal switching," which is referred to only incidentally, except in the discussion of cases in several footnotes — are taken up in Chapter XVIII of our book, especially in Section 3, shown in the Table of Contents as entitled "Closed and Open Terminals," and in Section 2 of Chapter XVI, where, under the heading "The Per Diem Agreement," we consider the general scheme of car interchange.

The words "interchange," "open terminals," and "closed terminals" all appear in the index to our volume, as do the words "divisions," "through rates," "through routes," and "terminals," to which reference is made by Professor Ripley in the several other passages cited above.

KENNETH F. BURGESS,
HOMER B. VANDERBLUE.

I AM happy to make avowal of error in this regard. These topics were by no means ignored, as was stated in the review.

The erroneous impression conveyed by my review may be extenuated, perhaps, by reason of two facts. The first of these is intense preoccupation by their importance. Being enabled to delve practically to the bottom of the strategy and diplomacy of corporate relationships, I have been necessarily brought into intimate contact with railway matters in con-

nection with consolidation. The truth was borne in upon me, more and more, that "the search for the long haul, as one old timer put it, was the beginning and the end of the practical railway man's education." And, similarly, the basic importance of terminal improvement in operation, in contradistinction to economy out on the line, was forced into the foreground. Thus impressed, it was my intention to emphasize the need of greater attention to these subjects than any of the authors whose books were noticed had devoted to them. But to affirm inadequacy in the treatment of a topic is quite a different matter from averring its total neglect. I was in error in conveying the latter impression.

The second circumstance to be pleaded in extenuation is that, in the book in question, the treatment of these important topics was mainly legal; whereas it is the economic treatment that I was in search of and that is most needed. The divided authorship of this volume is written all over it. The treatment of both these topics is, in my judgment, too brief; and it is too largely legal. This leaves me still unchanged in the conviction that there is an inviting field for research and for publication thus exposed.

By way of exposition of what has already been accomplished in the field of terminal operation, I am now under engagement to contribute two articles to the Harvard Business Review; in which I hope at least to open up the subject.

In closing this explanation, I wish again to affirm the excellence of Vanderblue and Burgess's treatise in its chosen field. The impossibility that the able authors of so substantial a contribution to our knowledge of transportation economics should either have overlooked or been ignorant of matters so pregnant for the future doubtless should have warned me to be less sweeping in generalization than might have been the case with authors of less patent competence. May we not hope that in future editions the authors will see fit to develop these topics more fully, even at the expense of deletion of less important matters.

WILLIAM Z. RIPLEY.

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